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LAKE MICHIGAN WATER QUALITY AND LAKE BED SURVEY 1973



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Springfield, Illinois

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Dr. Richard H. Briceland, Director

The Honorable Dan Walker
Governor, State of Illinois

Honorable Members of the 79th
General Assembly, State of Illinois

Gentlemen:

The Illinois Environmental Protection Agency presents its report of the results of the Lake Michigan Water Quality and Lake Bed Survey for 1973. This survey is conducted on a continuing basis to evaluate the ecology and the quality of Lake Michigan.

Specific problems identified include concentrations of ammonia, phosphorus, and fecal coliform which continue to be found at undesirable levels at a large number of sampling stations. Samples of the lake bed have identified areas of pollution at some near shore stations and local problems at times have developed and resulted in the closing of some Lake County beaches.

It should be recognized that the wastewater effluent discharges to Lake Michigan from Illinois are few when compared with discharges from other adjoining States. This State must therefore continue to cooperate with and encourage other State and Federal efforts in Lake quality monitoring and control of pollution sources.

Sincerely,

A handwritten signature in dark ink, appearing to read "Richard H. Briceland", written over a horizontal line.

Richard H. Briceland

Acknowledgements

This report was prepared by the Region II Aquatic Biology Survey Unit of the Division of Water Pollution Control. The authors were Robert Schacht, Lawrence Kolczak, and Wallace Matsunaga. The report was typed by Beverly Gregory. Graphics were provided by the Support Services Section. Sample analyses were performed by the Chicago, Champaign, and Springfield laboratories.

WATER QUALITY EVALUATION, 1972-1973

pH - Values continued to be within the standard. There was no significant change in values between the two years.

AMMONIA (N) - Values continued to frequently exceed the standard.

MBAS - Values were within the standard.

CHLORIDES - Values were generally within the standards. There was no significant change in values between the two years.

CYANIDES - Values were generally within the standards. Two positive samples were found in 1973 shore water sampling.

FLUORIDES - Values continued to be generally within the standards. There was no significant change in values between the two years.

PHENOLS - Values continued to be within the standards.

SULFATES - Values continued to be within the standards.

PHOSPHORUS - Values continued to frequently exceed the standard.

TOTAL DISSOLVED SOLIDS - Values continued to be within the standards.

RADIONUCLIDES - Values continued to be within the standards.

FECAL COLIFORM - Annual geometric mean values at the Lake County shore water stations continued to be significantly higher than the Cook County stations.

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WATER QUALITY MONITORING

GENERAL INFORMATION

Lake Michigan serves a broad spectrum of purposes. It is the source of drinking water for 5 million residents of northeastern Illinois. Its recreational opportunities attract fishing, boating, swimming and other water-oriented interests. It is the avenue for domestic and international water-borne commerce. Its readily available waters for industry and commerce encouraged the growth and development of the greater Chicago metropolitan area into one of the largest industrial-commercial complexes in the United States. Ironically, Lake Michigan has also been the recipient of municipal and industrial wastes throughout its watershed.

Discharges from industrial complexes located along the southwestern shore of Lake Michigan affect the quality of Illinois waters. These discharges consist of process, cooling, dilution and other waste waters and have adverse effects on the local environment as well as the total ecology of the lake. Inadequately treated sewage effluents, bypasses from overloaded sewage treatment facilities and combined sewer overflows contribute to the lake's organic enrichment. The aging or eutrophication of Lake Michigan is accelerated by the addition of nutrients from both industrial and municipal discharges. While the number of discharges in Illinois are few and have little impact on the overall quality of Lake Michigan, local problems have resulted in the closing of beaches in Lake County.

In addition to man-made inputs to Lake Michigan, lake water quality is also affected by natural phenomena. During most of the year, from about April to November, the lake is thermally stratified. The formation of thermoclines during this period prevents the free exchange of dissolved oxygen between these layers and results in the reduction of dissolved oxygen near the lake bottom. Stratification is destroyed during late fall and spring overturns. Mixing occurs between the surface and bottom waters during these overturns, resulting in some resuspension of settled bottom deposits. At these times, there are noticeable and measurable increases in turbidity, color and mineral concentrations.

Lake currents also influence water quality. Effluents may be carried a considerable distance from the point of discharge through physical transport or may remain near the point of discharge. In these areas of influence sludge-like deposits may accumulate on the lake bottom and be colonized by aquatic organisms able to tolerate such biologically degraded habitats.

Tributary streams and rivers add to the sediment and nutrient levels of the lake. As these waters flow downstream, sediments, nutrients, fertilizers, pesticides and other substances are acquired through erosion, land runoff, and from industrial and municipal waste discharges.

Climatic factors, too, exert their influence on lake water quality. Increases in bacteria counts, suspended and dissolved solids and organic and nutrient levels can be expected following a storm and resulting storm water runoff.

Recognizing the importance of Lake Michigan as a natural asset, the Illinois 75th General Assembly authorized the Environmental Protection Agency to ".... regularly conduct water quality and lake bed surveys to evaluate the ecology and the quality of water in Lake Michigan." Pursuant to this mandate the State of Illinois conducts an on-going program of water quality and biological monitoring in Lake Michigan.

The monitoring program of water quality and lake bed sampling has provided information on the condition of the Illinois waters of Lake Michigan. As data is gathered on a continuing basis, it should be possible to determine long term trends in lake water quality as well as discern improvements or deterioration of the lake bottom.

Lake water quality has been evaluated on the basis of the water quality standards promulgated by the Illinois Pollution Control Board. Three categories of standards are in force in Illinois depending on the use (s) to be made of the particular body of water. The General Standards are designed to "..... protect the State's water for aquatic life, agricultural use, primary and secondary contact use, and most industrial uses, and ensure the aesthetic quality of the State's aquatic environment." Waters used as sources of potable water and for food processing must, in addition to meeting the General Standards, meet the more stringent Public and Food Processing Water Supply Standards. Additionally, nine critical parameters were designated as part of the Lake Michigan Standards. Lake waters, in addition to meeting the General and Public and Food Processing Water Supply Standards, must meet the strict standards for:

Dissolved Oxygen	Phosphorus
pH	Total Dissolved Solids
Ammonia Nitrogen	Fecal Coliform
Chloride	Temperature
Sulfate	

In this report the shore and offshore data were evaluated on the basis of the Lake Michigan standards for the above nine parameters. Standards applicable to the Public and Food Processing Water Supply were used to evaluate those parameters not specifically covered by the Lake Michigan standard. Shore water quality, which is adversely affected by waste discharges, land runoff, and storms to a much greater extent than offshore water, was evaluated on the basis of the General Standards for those parameters not part of the Lake Michigan Standards.

Data on lake water quality were obtained from (1) shore waters, (2) municipal water filtration plants and (3) lake monitoring stations located 5 miles offshore. Additional samples were collected in Calumet Harbor to monitor water quality in this confined area. All samples were delivered to the Chicago Laboratory of the Illinois Environmental Protection Agency within six hours of collection. The cyanide, phenol, ammonia and metals samples were treated with

preservatives to retard any chemical or biological alteration of their composition. Samples for bacterial analysis were collected in sterilized bottles and put on ice prior to delivery to the laboratory. Plankton samples were preserved with a formalin solution.

Shore Water Sampling

The thirty-one beaches listed below were the shore water sampling stations during 1973. Samples were collected twice per month, with a total number of 14 samplings at each station. Samples were collected just below the surface in approximately 2½ feet of water. The shore water sampling season extended from April 9 to October 29, 1973.

NORTH SHORE BEACHES (Figure 1)

Winthrop Harbor - Main Street
Ill. Beach State Park
Zion - Route 173
Waukegan - North
Waukegan - Central
North Chicago - Foss Park
Lake Bluff - Center Avenue
Lake Forest - Westminster Avenue
Highwood - Walker Avenue
Highland Park - Park Avenue
Highland Park - Ravine Drive
Highland Park - Cary Avenue
Glencoe - Park Avenue
Winnetka - Lloyd Park
Kenilworth - Kenilworth Avenue
Wilmette - Lake Avenue
Evanston - Dempster Street
Evanston - Elliot Park

CHICAGO BEACHES (Figure 2)

Touhy Avenue
Loyola Park
Bryn Mawr Avenue
Foster Avenue
Montrose Avenue
North Avenue
Oak Street
Roosevelt Road
31st Street
49th Street
63rd Street
76th Street
100th Street

Offshore Water Sampling

Lake samples for monitoring offshore or "open" water quality were obtained at the intakes of those municipal water filtration plants utilizing Lake Michigan as their source of water supply and by boat 5 miles offshore.

Raw water samples were collected monthly at these twelve water plants: Zion-Benton, Waukegan, North Chicago, Lake Forest, Highland Park, Glencoe, Winnetka, Kenilworth, Wilmette, Evanston, Chicago Central and Chicago South. Information on water plant intakes is presented in Table 1.

Additional water samples were collected by boat at eight stations located 5 miles offshore from the Illinois-Wisconsin State Line, Waukegan, Lake Bluff, Highland Park, Wilmette, Chicago (Montrose and Burnham Park Harbors) and Illinois-Indiana State Line. Surface, mid-depth and near bottom water samples were collected at each station for water quality monitoring during four cruises in June, July, August and November 1973.

Figure 1. Locations of North Shore beaches and facilities influencing their quality.

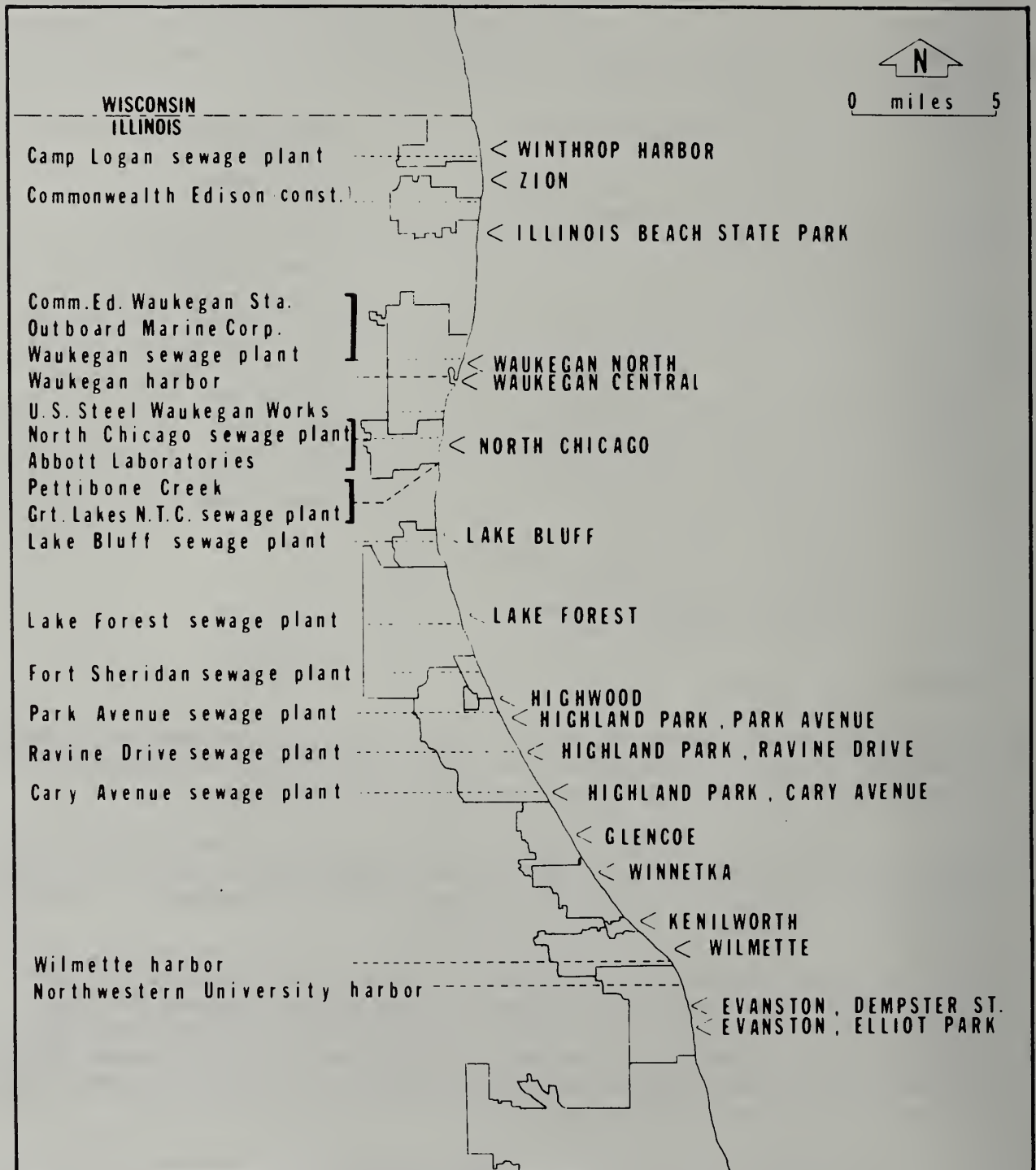


Figure 2. Locations of Chicago beaches and facilities influencing their quality.

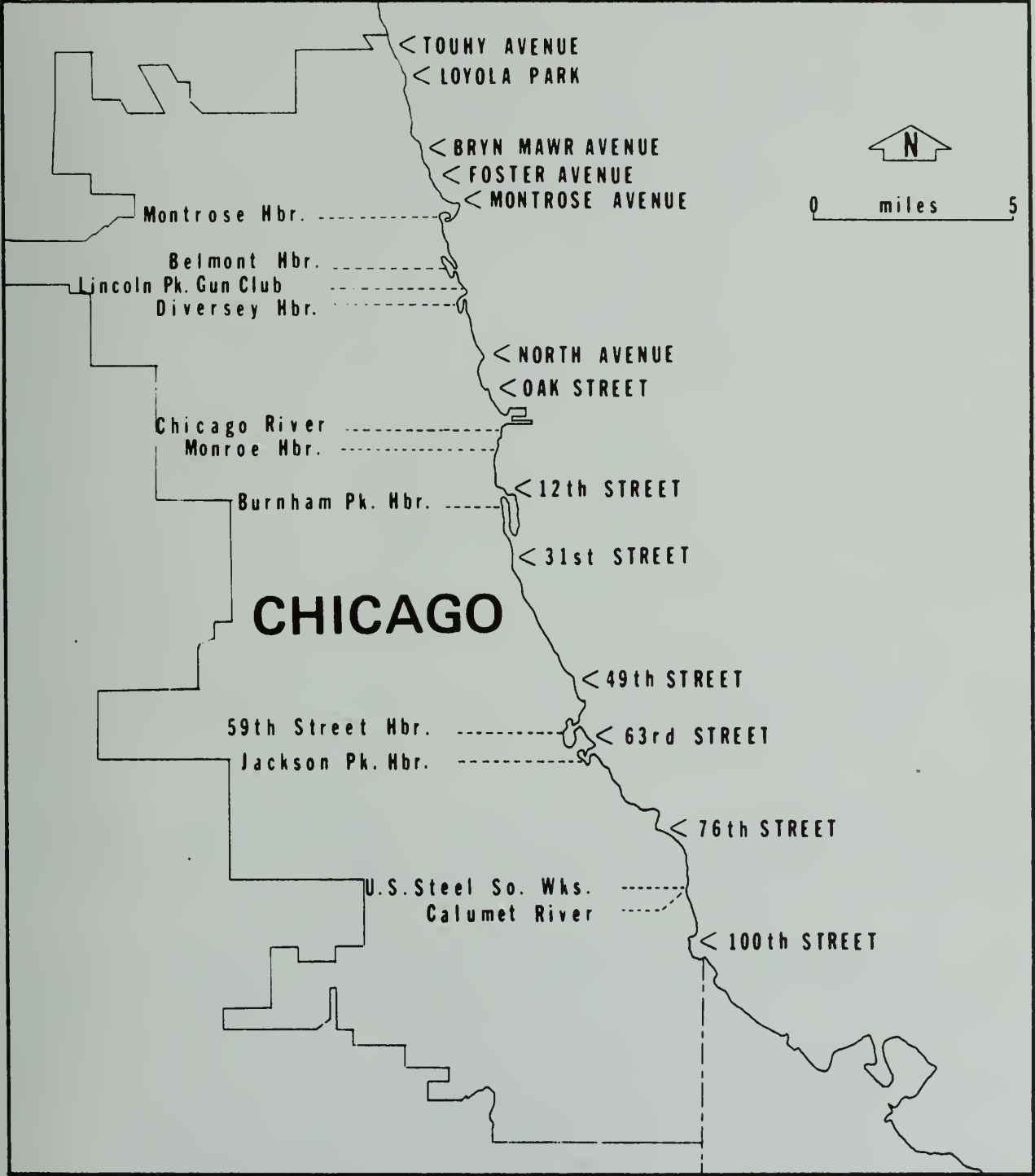


Table 1. Locations of raw water intakes monitored.

NAME OF PLANT	NUMBER OF INTAKES	DISTANCE OF INTAKE FROM SHORE (FT.)	DEPTH DRAWN FROM (FT.)
Zion-Benton	1	2,700	37
Waukegan	2	Shore 6,200	5 35
North Chicago	1	6,500	28
Lake Forest	2	3,900 6,500	24 30
Highland Park	3	1,000 2,000 3,500	9 20 28
Glencoe	2	2,000 3,300	25 18
Winnetka	2	1,200 3,000	20 15
Kenilworth	1	2,100	20
Wilmette	2	3,300 4,500	21 29
Evanston	3	1,800 2,600 5,600	16 18 28
Chicago Central	2	Shore 13,000	20 35
Chicago South	2	Shore 12,100	24 32

Monthly cruises were made to Calumet Harbor in June, July, August and November 1973 to obtain harbor samples for water quality analysis. These samples were collected at the State Line and Calumet River mouth.

The configuration of the harbor and protecting breakwater restricts the free movement of water between the lake and the harbor. The increased residence time within the harbor, combined with the effects of industrial discharges, storm-water runoff and other harbor-associated waste discharges, results in water of degraded quality within the harbor.

TURBIDITY

Turbidity is attributable to suspended and colloidal matter and is analyzed routinely on sources of public water supply to determine the degree of treatment required. There is no standard for turbidity in Lake Michigan.

Shore Water

Turbidity measurements of the shore water are not particularly valuable since they are severely affected by the surf conditions. The table indicates minimum, maximum and median values. The median was chosen, rather than the average, because there was such a wide range of values (Table 2).

Table 2. Shore Water turbidity in Lake Michigan during 1973. Values are expressed in Jackson turbidity units (JTU).

SAMPLING LOCATION	RANGE JTU	MEDIAN VALUE JTU	SAMPLES ANALYZED
Winthrop Harbor	1 - 60	8	13
Zion	1 - 55	6	13
Illinois Beach State Park	1 - 55	23	13
Waukegan North	1 - 34	13	13
Waukegan Central	1 - 35	17	13
North Chicago	1 - 100	34	13
Lake Bluff	1 - 175	33	13
Lake Forest	1 - 130	40	13
Highland	1 - 140	37	13
Highland Park - Park Ave.	1 - 115	35	13
Highland Park - Ravine Dr.	3 - 210	92	6
Highland Park - Cary Ave.	1 - 185	30	13
Glencoe	2 - 55	6	10
Winnetka	1 - 60	15	13
Kenilworth	2 - 55	8	11
Wilmette	1 - 96	16	13
Evanston - Dempster St.	1 - 85	6	13
Evanston - Elliot Park	1 - 85	5	13
Chicago - Touhy Ave.	1 - 95	20	13
Chicago - Loyole Pk.	1 - 90	7	13
Chicago - Bryn Mawr Ave.	1 - 26	4	12
Chicago - Foster Ave.	1 - 90	3	13
Chicago - Montrose Ave.	1 - 110	5	13
Chicago - North Ave.	1 - 80	3	13
Chicago - Oak St.	1 - 34	2	12
Chicago - 12th St.	1 - 23	3	12
Chicago - 31st St.	1 - 95	6	13
Chicago - 49th St.	1 - 6	2	10
Chicago - 63rd St.	1 - 70	3	13
Chicago - 76th St.	1 - 70	3	13
Chicago - 100th St.	1 - 55	3	13

Offshore Stations

As might be expected, turbidity levels were very low at the offshore stations. The maximum values at the surface, mid-depth and bottom stations were 3, 1 and 2 JTU, respectively. The average of 64 lake samples was 1 JTU.

Water Plants

The maximum turbidities recorded in 1973 ranged from 25 to 86 JTU. Averages ranged from 6 to 30 JTU. For all plants the annual average was 17 JTU. With 10 JTU as a reference standard, samples with higher turbidities constituted from 25 to 63.6% of the total samples from individual plants. Considering all samples, 41.2% had turbidities higher than the reference standard (Table 3).

Calumet Harbor

Eight samples were analyzed for turbidity in 1973. The maximum values recorded at the State Line and Calumet River Mouth stations were 4 and 3 JTU, respectively. The harbor average was 2 JTU (Table 3).

Table 3. Turbidity levels recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Values are expressed in Jackson turbidity units (JTU).

SAMPLING LOCATION	RANGE	AVERAGE	NUMBER OF SAMPLES EXCEEDING 10 UNITS
WATER PLANTS			
Zion-Benton	2 - 46	14	4 of 11
Waukegan	2 - 60	14	5 of 12
North Chicago	1 - 52	12	3 of 10
Lake Forest	1 - 85	30	3 of 8
Highland Park	2 - 75	25	6 of 12
Glencoe	1 - 62	16	5 of 12
Winnetka	2 - 44	19	7 of 11
Kenilworth	1 - 78	24	7 of 12
Wilmette	1 - 86	19	5 of 12
Evanston	0 - 56	22	5 of 12
Chicago Central	0 - 25	6	3 of 12
Chicago South	0 - 26	6	3 of 12
CALUMET HARBOR			
State Line	0 - 4	2	0 of 4
Mouth, Calumet River	1 - 3	2	0 of 4

TEMPERATURE

In June 1971, the Pollution Control Board adopted thermal regulations which established discharge requirements for sources of heated effluent. The discharges must not cause the water temperature, outside of an accepted mixing zone, to exceed the maximum specified for each month of the year.

Shore Water

Of 345 temperature measurements, 11 exceeded the allowable monthly maximum. This was due to an unseasonably warm period in late April, and there were no sources of thermal discharge in the vicinity of the violations (Table 4).

Table 4. Maximum Lake Michigan shore water temperatures for 1973. Values are expressed in degrees Fahrenheit.

Standard: Maximum	55°	60°	70°	80°	80°	80°	65°
SAMPLING LOCATION	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.
Winthrop Harbor	48	51	55	68	71	63	49
Zion	48	52	55	68	68	63	49
Illinois Beach State Park	48	54	57	68	71	63	49
Waukegan North	--	56	64	70	72	63	61
Waukegan Central	--	59	64	69	72	63	57
North Chicago	--	52	57	69	72	62	53
Lake Bluff	--	53	57	71	72	62	53
Lake Forest	--	56	57	71	72	62	52
Highwood	--	56	57	72	72	62	53
Highland Park - Park Ave.	--	54	57	72	72	62	53
Highland Park - Ravine Dr.	--	57	57	72	--	--	--
Highland Park - Cary Ave.	--	53	57	72	72	62	53
Glencoe	--	53	54	72	73	62	53
Winnetka	--	56	54	72	73	62	56
Kenilworth	57	53	56	72	71	63	58
Wilmette	57	53	58	72	71	63	58
Evanston - Dempster St.	53	53	56	73	73	63	60
Evanston - Elliot Park	54	53	60	73	73	63	61
Chicago - Touhy Ave.	54	53	58	72	73	63	63
Chicago - Loyola Park	54	53	60	72	73	62	63
Chicago - Bryn Mawr. Ave.	61	52	61	73	73	63	63
Chicago - Foster Ave.	58	53	58	73	73	63	62
Chicago - Montrose Ave.	57	52	59	72	73	63	62
Chicago - North Ave.	60	53	60	72	74	63	60
Chicago - Oak St.	57	54	60	72	74	63	61
Chicago - 12th St.	56	53	58	72	75	63	62
Chicago - 31st St.	57	53	57	72	72	63	62
Chicago - 49th St.	57	52	56	70	70	63	62
Chicago - 63rd St.	58	53	60	72	73	63	62
Chicago - 76th St.	55	55	56	72	72	62	61
Chicago - 100th St.	54	52	61	74	74	67	60

Offshore Stations

None of the 58 offshore readings exceeded the monthly limits. Temperatures ranged from 49 to 73°F at the surface, 46 to 72°F at mid-depth and 47 to 71°F at the bottom. The averages at these three depths were 62, 57 and 55°F, respectively (Table 5). Year to year comparisons of averages or ranges should not be made due to limited sampling.

Table 5. Temperature range recorded 5-miles offshore in Lake Michigan in 1973. Values are expressed in degrees Fahrenheit.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Illinois-Wisconsin State Line	54 - 54	54	46 - 50	48	47 - 49	48
Waukegan	55 - 71	63	46 - 71	58	71 - 71	71
Lake Bluff	49 - 73	62	48 - 71	60	47 - 60	54
Highland	49 - 73	62	56 - 62	59	47 - 52	50
Wilmette	49 - 70	61	49 - 62	56	48 - 55	52
Chicago - Montrose Harbor	64 - 70	67	47 - 70	59	48 - 70	57
Chicago - Burnham Harbor	65 - 72	68	47 - 72	56	47 - 71	55
Illinois - Indiana State Line	50 - 71	62	47 - 71	61	47 - 70	60

Water Plants

In 1973, two of 134 temperature readings exceeded the monthly standards. A February temperature of 51°F was recorded at the Waukegan water plant and a March temperature of 48°F from the Wilmette plant exceeded the limits. The average of all readings was 51°F (Table 6).

Calumet Harbor

The four readings made in 1973 were within the monthly limits (June and November). The harbor average was 58°F.

Table 6. Maximum monthly temperatures recorded at municipal water filtration plants in 1973. Values are expressed in degrees Fahrenheit.

Standard:												
Maximum	45°	45°	45°	55°	60°	70°	80°	80°	80°	65°	60°	50°
SAMPLING LOCATION	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.
Zion - Benton	34	40	41	46	48	48	60	70	62	----	47	39
Waukegan	34	51	40	46	47	46	67	70	62	64	45	39
North Chicago	33	36	40	43	48	----	57	71	62	64	53	----
Lake Forest	34	37	42	47	----	49	68	----	62	----	----	39
Highland Park	35	----	----	47	52	50	70	72	62	64	48	39
Glencoe	33	35	40	44	50	49	69	70	62	65	44	38
Winnetka	33	35	42	47	52	50	70	71	60	65	45	----
Kenilworth	33	34	40	45	50	50	68	70	59	65	44	39
Wilmette	32	37	48	45	52	53	68	70	59	64	50	43
Evanston	32	38	42	47	54	55	70	72	61	64	47	41
Chicago Central	36	40	44	47	55	58	72	74	65	63	49	44
Chicago South	36	40	42	47	54	55	72	73	64	63	48	42

pH

The pH scale ranges from 0 (acidic) to 14 (alkaline) with neutrality being indicated by 7. Aquatic organisms having shells generally require a slightly alkaline environment, since the material of which the shell is composed dissolves in acid. Acidic conditions also result in increased toxicity of certain poisonous metals and compounds.

Shore Water

The pH of the shore water was generally 8.3. There was no appreciable regional variation, though the values at Waukegan's North Beach were slightly lower than at the other stations. None of the 388 shore water samples were in violation of the standard (Table 7).

Table 7. pH values for shore water during 1973. Values are expressed in pH units.

Standard: 7.0 - 9.0

SAMPLING LOCATION	RANGE pH units	MEDIAN pH units	SAMPLES ANALYZED
Winthrop Harbor	8.1 - 8.6	8.3	13
Zion	8.1 - 8.7	8.2	13
Illinois Beach State Park	8.1 - 8.6	8.2	13
Waukegan North	7.8 - 8.3	8.2	13
Waukegan Central	8.1 - 8.5	8.2	13
North Chicago	8.2 - 8.6	8.3	13
Lake Bluff	8.0 - 8.4	8.2	13
Lake Forest	8.0 - 8.5	8.3	13
Highwood	8.0 - 8.4	8.3	13
Highland Park - Park Ave.	8.0 - 8.5	8.3	13
Highland Park - Ravine Dr.	8.2 - 8.5	8.2	6
Highland Park - Cary Ave.	8.1 - 8.9	8.3	13
Glencoe	8.1 - 8.7	8.3	13
Winnetka	8.1 - 8.9	8.4	13
Kenilworth	8.1 - 8.5	8.3	11
Wilmette	8.0 - 8.6	8.3	13
Evanston - Dempster St.	7.9 - 8.6	8.4	13
Evanston - Elliot Pk.	8.0 - 8.6	8.3	13
Chicago - Touhy Ave.	8.0 - 8.6	8.3	13
Chicago - Loyola Pk.	8.1 - 8.5	8.3	13
Chicago - Bryn Mawr Ave.	8.0 - 8.7	8.3	12
Chicago - Foster Ave.	8.2 - 8.6	8.3	13
Chicago - Montrose Ave.	8.2 - 8.6	8.3	13
Chicago - North Ave.	8.0 - 8.5	8.3	13
Chicago - Oak St.	8.1 - 8.5	8.3	12
Chicago - 12th St.	8.0 - 8.5	8.4	12
Chicago - 31st St.	8.1 - 8.6	8.4	13
Chicago - 49th St.	8.2 - 8.5	8.4	10
Chicago - 63rd St.	8.2 - 8.6	8.3	13
Chicago - 76th St.	8.1 - 8.5	8.3	13
Chicago - 100th St.	7.8 - 8.5	8.2	13

Offshore Stations

The minimum and maximum pH values were 7.9 to 8.8 at the surface, 8.0 to 8.8 at mid-depth and 8.1 to 8.8 at the bottom. These values were within the standard. Median values were 8.4 at the surface and mid-depth stations and 8.3 at the bottom stations. The median of 66 samples was 8.4 (Table 8).

Table 8. pH concentrations recorded 5-miles offshore in Lake Michigan in 1973. Values are expressed in pH units.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	MEDIAN	RANGE	MEDIAN	RANGE	MEDIAN
Illinois-Wisconsin State Line	8.0 - 8.2	8.1	8.0 - 8.2	8.1	8.1 - 8.1	8.1
Waukegan	8.1 - 8.2	8.2	8.2 - 8.4	8.3	8.3 - 8.3	8.3
Lake Bluff	8.1 - 8.4	8.4	8.4 - 8.4	8.4	8.3 - 8.4	8.4
Highland	7.9 - 8.5	8.4	8.4 - 8.4	8.4	8.3 - 8.3	8.3
Wilmette	8.4 - 8.5	8.4	8.2 - 8.7	8.4	8.4 - 8.7	8.4
Chicago-Montrose Harbor	8.1 - 8.8	8.4	8.1 - 8.7	8.3	8.1 - 8.5	8.4
Chicago-Burnham Harbor	8.2 - 8.8	8.4	8.2 - 8.8	8.4	8.1 - 8.8	8.4
Illinois - Indiana State Line	8.0 - 8.7	8.5	8.2 - 8.8	8.5	8.3 - 8.8	8.6

Water Plants

The pH range in 1973 was from 7.7 to 8.6. All values were within the standard. Median values were from 8.1 to 8.2; the median of all samples was 8.2 (Table 9).

Calumet Harbor

The pH range within the harbor was from 7.5 to 8.4. None exceeded the standard. The median of eight samples was 8.2 (Table 9).

Table 9. pH concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Values are expressed in pH units.

Standard: 7.0 - 9.0			
SAMPLING LOCATION	RANGE	MEDIAN	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	7.9 - 8.4	8.2	11
Waukegan	7.9 - 8.6	8.2	12
North Chicago	8.0 - 8.5	8.2	10
Lake Forest	7.7 - 8.4	8.1	8
Highland Park	8.0 - 8.5	8.2	12
Glencoe	7.9 - 8.6	8.2	12
Winnetka	8.0 - 8.5	8.2	11
Kenilworth	8.0 - 8.6	8.2	12
Wilmette	8.0 - 8.6	8.2	12
Evanston	8.0 - 8.6	8.2	12
Chicago Central	8.0 - 8.5	8.2	12
Chicago South	8.0 - 8.4	8.2	12
CALUMET HARBOR			
State Line	7.5 - 8.4	8.2	4
Mouth, Calumet River	7.8 - 8.3	8.0	4

DISSOLVED OXYGEN

An adequate supply of dissolved oxygen is a requisite for sustaining life in the aquatic ecosystem. Dissolved oxygen is obtained through atmospheric diffusion, aeration created by turbulence from winds and waves and by the process of photosynthesis.

Except due to natural causes dissolved oxygen concentrations shall not be less than 90% of saturation for waters of Lake Michigan.

Offshore Stations

Saturation levels at the offshore stations ranged from 92 to 107% at the surface, 91 to 112% at mid-depth and 93 to 114% at the bottom. The average D.O. levels at these depths were 100, 102 and 101% of saturation, respectively. The average of 56 samples was 101% saturation (Table 10).

Table 10. Dissolved oxygen levels recorded 5-miles offshore in Lake Michigan in 1973. Values are expressed as percent saturation.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Illinois-Wisconsin State Line	106 - 107	106	105 - 107	106	101 - 103	102
Waukegan	98 - 105	102	99 - 101	100	99 - 99	99
Lake Bluff	100 - 101	100	102 - 109	106	97 - 114	106
Highland Park	101 - 104	102	107 - 112	110	99 - 102	100
Wilmette	92 - 101	98	92 - 107	101	103 - 106	104
Chicago - Montrose Harbor	97 - 102	100	91 - 109	100	95 - 107	101
Chicago - Burnham Harbor	99 - 100	100	95 - 102	99	94 - 103	99
Illinois - Indiana State Line	92 - 101	98	96 - 101	99	93 - 106	99

Water Plants

Dissolved oxygen measurements were not made at the water plants because of the artificial aeration induced by in-plant piping systems.

Calumet Harbor

Two samples from each Calumet Harbor station were analyzed for dissolved oxygen in 1973. At the State Line station D.O. levels were at 88 and 98% of saturation. For the Calumet River Mouth station saturation levels were 92 and 98%. The 88% saturation value in one of the State Line samples did not meet the D.O. standard.

AMMONIA NITROGEN (as N)

Ammonia is one of the compounds resulting from the metabolic activity of living organisms. It may be present in water due to agricultural runoff, certain industrial wastes and sewage. The primary source of ammonia in the Illinois watershed to Lake Michigan is sewage. Even in the effluents of conventional sewage treatment facilities, the concentrations of ammonia may be relatively high. Therefore it is not uncommon to find the high concentrations of ammonia in areas where sewage, treated or untreated, is discharged.

Shore Water

The average concentration of ammonia in the shore water was 0.10 mg/l. One unusually high concentration (9.4 mg/l) noted at Waukegan's North Beach was dropped from the data so that the average would be more representative of that station's general condition. A very obvious regional variation was noted, with the average at the Lake county stations being almost double that of the Cook county stations. Overall, 93% of the samples analyzed exceeded the standard. Because the value specified in the standard is low when compared to the concentrations detected in the shore water, the per cent of violations did not vary greatly from station to station (Table 11).

Table 11. Ammonia Nitrogen (as N) concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

Standard: 0.02 mg/l							
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD		REGIONAL COMPARISON	OVERALL RESULTS	
Winthrop Harbor	0.03 - 0.25	0.10	13 of 13	100%	12 LAKE COUNTY STATIONS	ALL 31 ILLINOIS STATIONS 356 of 384 (93%) SAMPLES EXCEEDED STANDARD AVG.-0.10 mg/l	
Zion	0.03 - 0.19	0.09	13 of 13	100%			
Illinois Beach State Pk.	0.03 - 0.28	0.10	13 of 13	100%			
Waukegan North	0.04 - 0.90	0.30	13 of 13	100%			
Waukegan Central	0.04 - 0.45	0.18	13 of 13	100%	142 of 149 (95%)		
North Chicago	0.04 - 0.31	0.13	13 of 13	100%	SAMPLES		
Lake Bluff	0.03 - 0.28	0.09	13 of 13	100%	EXCEEDED		
Lake Forest	0.03 - 0.11	0.07	13 of 13	100%	STANDARD		
Highwood	0.02 - 0.12	0.10	12 of 13	92%	AVG.-0.13 mg/l		
Highland Park - Park Ave.	0.04 - 0.22	0.09	13 of 13	100%			
Highland Park - Ravine Dr.	0.03 - 0.35	0.15	6 of 6	100%			
Highland Park - Cary Ave.	0.02 - 0.41	0.14	12 of 13	92%			
Glencoe	0.02 - 0.12	0.08	11 of 13	85%			
Winnetka	0.02 - 0.19	0.09	12 of 13	92%			
Kenilworth	0.00 - 0.09	0.06	9 of 11	82%	19 COOK COUNTY STATIONS		
Wilmette	0.02 - 0.12	0.07	12 of 13	92%			
Evanston - Dempster St.	0.00 - 0.11	0.06	8 of 9	89%			
Evanston - Elliot Pk.	0.00 - 0.10	0.06	11 of 13	85%			
Chicago - Touhy Ave.	0.00 - 0.11	0.06	11 of 13	85%	214 of 235 (91%)		
Chicago - Loyola Pk.	0.00 - 0.14	0.07	11 of 13	85%			
Chicago - Bryn Mawr Ave.	0.02 - 0.11	0.07	11 of 12	92%	SAMPLES		
Chicago - Foster Ave.	0.00 - 0.09	0.05	10 of 13	78%	EXCEEDED		
Chicago - Montrose Ave.	0.00 - 0.20	0.07	12 of 13	92%	STANDARD	AVG.-0.07 mg/l	
Chicago - North Ave.	0.00 - 0.18	0.07	12 of 13	92%			
Chicago - Oak St.	0.03 - 0.17	0.08	12 of 12	100%			
Chicago - 12th St.	0.03 - 0.45	0.10	12 of 12	100%			
Chicago - 31st St.	0.00 - 0.65	0.11	12 of 13	92%			
Chicago - 49th St.	0.00 - 0.09	0.06	9 of 10	90%			
Chicago - 63rd St.	0.03 - 0.15	0.07	13 of 13	100%			
Chicago - 76th St.	0.04 - 0.15	0.08	13 of 13	100%			
Chicago - 100th St.	0.04 - 0.11	0.10	13 of 13	100%			

Offshore Stations

The maximum ammonia concentrations ranged from 0.07 to 0.14 mg/l at the surface stations, 0.06 to 0.11 mg/l at the mid-depth stations and 0.06 to 0.15 mg/l at the bottom stations. Averages at these depths were 0.08, 0.06 and 0.08 mg/l, respectively. The average concentration of 65 samples was 0.07 mg/l. Percent violations were 100, 95 and 90% at the surface, mid-depth and bottom stations, respectively. Overall, 95% of the samples exceeded the standard (Table 12).

Table 12. Ammonia nitrogen (as N) concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	Standard: 0.02 mg/l					
	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Illinois - Wisconsin State Line	0.10 - 0.14	0.12	0.05 - 0.10	0.08	0.07 - 0.10	0.08
Waukegan	0.07 - 0.09	0.08	0.07 - 0.10	0.08	0.09 - 0.09	0.09
Lake Bluff	0.07 - 0.10	0.08	0.07 - 0.09	0.08	0.07 - 0.10	0.08
Highland Park	0.07 - 0.12	0.09	0.05 - 0.11	0.08	0.06 - 0.13	0.10
Wilmette	0.04 - 0.08	0.06	0.04 - 0.09	0.07	0.10 - 0.15	0.12
Chicago - Montrose Harbor	0.04 - 0.13	0.07	0.04 - 0.07	0.06	0.05 - 0.09	0.06
Chicago - Burnham Harbor	0.06 - 0.10	0.07	0.00 - 0.06	0.04	0.00 - 0.09	0.04
Illinois - Indiana State Line	0.04 - 0.07	0.05	0.03 - 0.07	0.05	0.03 - 0.06	0.04

Water Plants

The maximum ammonia concentrations recorded at the water plants ranged from 0.10 to 0.50 mg/l. Averages ranged from 0.05 to 0.13 mg/l, which are indicative of the high concentrations found in 1973. For all plants the average concentration was 0.08 mg/l. Values exceeding 0.02 mg/l ranged from 83 to 100% of the samples at each plant. Overall, 91% of the samples exceeded the standard (Table 13).

Calumet Harbor

All seven harbor samples analyzed for ammonia in 1973 exceeded the standard. Concentrations ranged from 0.05 to 0.50 mg/l. The average of all samples was 0.16 mg/l (Table 13).

Table 13. Ammonia nitrogen (as N) concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	Standard: 0.02 mg/l		
	RANGE mg/l	AVERAGE mg/l	NUMBER OF SAMPLES EXCEEDING STANDARD
WATER PLANTS			
Zion-Benton	0.02 - 0.50	0.13	10 of 11
Waukegan	0.02 - 0.14	0.06	11 of 12
North Chicago	0.02 - 0.10	0.05	9 of 10
Lake Forest	0.01 - 0.20	0.07	7 of 8
Highland Park	0.00 - 0.12	0.06	11 of 12
Glencoe	0.00 - 0.20	0.07	11 of 12
Winnatka	0.00 - 0.22	0.10	9 of 11
Kenilworth	0.04 - 0.16	0.08	12 of 12
Wilmette	0.03 - 0.12	0.07	12 of 12
Everston	0.02 - 0.19	0.08	11 of 12
Chicago Central	0.01 - 0.13	0.06	10 of 12
Chicago South	0.01 - 0.15	0.06	11 of 12
CALUMET HARBOR			
State Line	0.05 - 0.07	0.06	4 of 4
Mouth, Calumet River	0.10 - 0.50	0.31	3 of 3

MBAS

The Methylene Blue Active Substances test is used to detect the wetting and foaming ingredients commonly found in synthetic detergents. Although any detergent related waste may be involved, the most common source of MBAS is domestic sewage.

Shore Water

In the 387 shore water samples, the average concentration of MBAS was 0.10 mg/l. Values ranged from 0.00 mg/l to 0.50 mg/l, but there was no appreciable variation between the averages from station to station.

Offshore Stations

The range of MBAS concentrations at the offshore stations was 0.00 to 0.30 mg/l at the surface, 0.00 to 0.20 mg/l at mid-depth and 0.00 to 0.20 at the bottom. All values were within the standard. The average at each of the three depths was 0.10 mg/l. The average of all 65 lake samples was also 0.10 mg/l.

Water Plants

The maximum MBAS concentrations ranged from 0.20 to 0.40 mg/l in 1973. None exceeded the standard. Individual water plant averages ranged from 0.10 to 0.15 mg/l. The average of all samples was 0.10 mg/l (Table 14).

Calumet Harbor

The maximum concentrations were 0.20 mg/l at the State Line station and 0.30 mg/l at the Calumet River Mouth station. The average of the eight samples was 0.10 mg/l (Table 14).

Table 14. MBAS concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	0.10 - 0.25	0.10	11
Waukegan	0.10 - 0.40	0.10	12
North Chicago	0.10 - 0.20	0.10	10
Lake Forest	0.00 - 0.25	0.15	7
Highland Park	0.10 - 0.20	0.10	12
Glencoe	0.10 - 0.25	0.10	12
Winnetke	0.10 - 0.25	0.10	11
Kenilworth	0.00 - 0.25	0.10	12
Wilmette	0.10 - 0.25	0.10	12
Evenston	0.00 - 0.25	0.10	12
Chicago Central	0.10 - 0.20	0.10	12
Chicago South	0.00 - 0.25	0.10	12
CALUMET HARBOR			
State Line	0.00 - 0.20	0.10	4
Mouth, Calumet River	0.10 - 0.30	0.20	4

CHLORIDE

One of the most common chemical constituents found in surface waters, chlorides are continually entering Lake Michigan through natural processes. Certain industrial wastes may be significant contributors, and currently, ferric chloride is being used at several of the sewage treatment plants tributary to Lake Michigan to reduce phosphorus levels in their effluents.

Shore Water

The average concentration of chloride in the shore water was 9 mg/l. A slight regional variation was evident, with the Lake county samples averaging 10 mg/l and those from Cook county averaging 8 mg/l. Overall, nine of the 387 samples collected (2%) exceeded the standard. All but one of the violations occurred at stations in Lake county (Table 15).

Table 15. Chloride concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

Standard: 12.0 mg/l

SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	8 - 12	9	0 of 13 0	12 LAKE COUNTY STATIONS	
Zion	8 - 13	9	1 of 13 8%		
Illinois Beach State Pk.	8 - 14	9	1 of 13 8%		
Waukegan North	8 - 31	13	3 of 13 23%		
Waukegan Central	8 - 12	9	0 of 13 0		
North Chicago	8 - 12	10	0 of 13 0	8 of 148 (5%) SAMPLES EXCEEDED STANDARD	ALL 31 ILLINOIS STATIONS
Lake Bluff	8 - 10	9	0 of 13 0		
Lake Forest	8 - 10	8	0 of 12 0		
Highwood	8 - 11	9	0 of 13 0		
Highland Park - Park Ave.	8 - 15	9	1 of 13 8%		
Highland Park - Ravine Dr.	8 - 16	10	1 of 6 17%	AVG.-10 mg/l	9 of 387 (2%) SAMPLES EXCEEDED STANDARD
Highland Park - Cary Ave.	8 - 23	10	1 of 13 8%		
Glencoe	8 - 14	9	1 of 13 8%		
Winnetka	8 - 10	8	0 of 13 0		
Kenilworth	8 - 10	8	0 of 11 0		
Wilmette	8 - 10	8	0 of 13 0	19 COOK COUNTY STATIONS	AVG.-9 mg/l
Evanston - Demp. St.	8 - 10	8	0 of 13 0		
Evanston - Elliot Pk.	8 - 11	9	0 of 13 0		
Chicago - Touhy Ave.	8 - 10	8	0 of 13 0		
Chicago - Loyola Pk.	8 - 10	8	0 of 13 0		
Chicago - Bryn Mawr Ave.	8 - 10	8	0 of 12 0	1 of 239 (0%) SAMPLES+ EXCEEDED STANDARD	
Chicago - Foster Ave.	8 - 11	8	0 of 13 0		
Chicago - Montrose Ave.	8 - 11	8	0 of 13 0		
Chicago - North Ave.	8 - 10	8	0 of 13 0		
Chicago - Oak St.	8 - 10	9	0 of 12 0		
Chicago - 12th St.	8 - 11	9	0 of 12 0	AVG.-8 mg/l	
Chicago - 31st St.	8 - 11	9	0 of 13 0		
Chicago - 49th St.	8 - 10	9	0 of 10 0		
Chicago - 63rd St.	8 - 11	9	0 of 13 0		
Chicago - 76th St.	8 - 11	9	0 of 13 0		
Chicago - 100th St.	8 - 10	9	0 of 13 0		

Offshore Stations

There were no appreciable differences in chloride concentrations at the three sampling depths. For all depths the maximum concentration was 9 mg/l. The average of the 65 offshore samples was 8 mg/l (Table 16).

Table 16. Chloride concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Illinois - Wisconsin State Line	9 - 9	9	9 - 9	9	8 - 9	8
Waukegan	8 - 9	8	8 - 8	8	8 - 8	8
Lake Bluff	8 - 9	8	8 - 8	8	8 - 8	8
Highland Park	8 - 8	8	8 - 8	8	8 - 8	8
Wilmette	8 - 9	8	8 - 8	8	8 - 9	8
Chicago - Montrose Harbor	8 - 8	8	8 - 8	8	8 - 8	8
Chicago - Burnham Harbor	8 - 9	8	8 - 8	8	8 - 8	8
Illinois - Indiana State Line	8 - 8	8	8 - 9	8	8 - 9	8

Water Plants

The maximum chloride concentrations ranged from 10 to 13 mg/l. Averages ranged from 8 to 10 mg/l. For all plants the annual average was 9 mg/l. The chloride concentration in one of 136 samples exceeded 12 mg/l (Table 17).

Calumet Harbor

The chloride concentrations ranged from 9 to 13 mg/l. The maximum value was collected from the Calumet River Mouth station. The average of all samples was 10 mg/l (Table 17).

Table 17. Chloride concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

Standard: 12.0 mg/l			
SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	NUMBER OF SAMPLES EXCEEDING STANDARD
WATER PLANTS			
Zion - Benton	8 - 10	9	0 of 11
Waukegan	7 - 10	8	0 of 12
North Chicago	8 - 10	9	0 of 10
Lake Forest	8 - 12	10	0 of 8
Highland Park	8 - 10	9	0 of 12
Glencoe	7 - 11	9	0 of 12
Winnetka	8 - 12	9	0 of 11
Kenilworth	7 - 11	9	0 of 12
Wilmette	8 - 13	9	1 of 12
Evanston	8 - 10	9	0 of 12
Chicago Central	8 - 10	9	0 of 12
Chicago South	8 - 11	9	0 of 12
CALUMET HARBOR			
State Line	9 - 9	9	0 of 4
Mouth, Calumet River	9 - 13	11	1 of 4

CYANIDE

Cyanides are extremely toxic compounds frequently associated with industrial wastes. The toxicity of these compounds varies with temperature, water quality and the organisms involved.

Shore Water

Of the 378 shore water samples analyzed, there were two detections of cyanide, one of which exceeded the standard. Both detections were samples from Waukegan's North Beach. The concentrations reported were 0.02 and 0.23 mg/l.

Offshore Stations

Measurable concentrations of cyanide were not found in the 30 offshore samples.

Water Plants

At the water plants cyanide analyses were performed on 136 samples in 1973. Measurable concentrations were not found.

Calumet Harbor

Three samples from each Calumet Harbor station were analyzed for cyanide during the year. One, from the Calumet River Mouth station, had a cyanide concentration of 0.06 mg/l, which exceeded both the Public Water Supply and General standards. Measurable concentrations were not found in the other five samples.

FLUORIDE

Fluorides are commonly used in the production of steel, aluminum, thermo-plastics and refrigerants. At certain levels in drinking water, they have been shown to reduce the incidence of dental caries. Excessive concentrations, however, can cause discoloration of the teeth. The U.S. Public Health Service standard for fluoride varies with temperature, because it was assumed that water consumption is temperature related.

Shore Water

In the shore water, the fluoride concentration was very stable and all the results were well below the level specified in the standard. The average value was 0.1 mg/l and, in the 180 samples analyzed, 0.2 mg/l was the maximum (Table 18).

Table 18. Fluoride concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

Standard: 1.4 mg/l					
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	0.1 - 0.2	0.1	0 of 6	12 LAKE COUNTY STATIONS	ALL 31 ILLINOIS STATIONS
Zion	0.1 - 0.2	0.1	0 of 6		
Illinois Beach State Pk.	0.1 - 0.2	0.1	0 of 6		
Waukegan North	0.1 - 0.2	0.1	0 of 6		
Waukegan Central	0.1 - 0.2	0.1	0 of 6	0 of 69	
North Chicago	0.1 - 0.2	0.1	0 of 6	SAMPLES EXCEEDED	
Lake Bluff	0.1 - 0.2	0.1	0 of 6		
Lake Forest	0.1 - 0.2	0.1	0 of 6		
Highwood	0.1 - 0.2	0.1	0 of 6	AVG. - 0.1 mg/l	
Highland Park - Park Ave.	0.1 - 0.2	0.1	0 of 6		
Highland Park - Ravine Dr.	0.1 - 0.2	0.1	0 of 3		0 of 170 SAMPLES EXCEEDED STANDARD
Highland Park - Cary Ave.	0.1 - 0.2	0.1	0 of 6		
Glencoe	0.1 - 0.2	0.2	0 of 6		
Winnetka	0.1 - 0.2	0.1	0 of 6		
Kenilworth	0.1 - 0.2	0.2	0 of 5	19 COOK COUNTY STATIONS	AVG.- 0.1 mg/l
Wilmette	0.1 - 0.2	0.2	0 of 6		
Evanston - Dempster St.	0.1 - 0.2	0.1	0 of 6		
Evanston - Elliot Pk.	0.1 - 0.2	0.1	0 of 6		
Chicago - Touhy Ave.	0.1 - 0.2	0.1	0 of 6	0 of 111	
Chicago - Loyola Pk.	0.1 - 0.2	0.1	0 of 6		
Chicago - Bryn Mawr Ave.	0.1 - 0.1	0.1	0 of 6		
Chicago - Foster Ave.	0.1 - 0.1	0.1	0 of 6		
Chicago - Montrose Ave.	0.1 - 0.1	0.1	0 of 6	SAMPLES EXCEEDED STANDARD	
Chicago - North Ave.	0.1 - 0.2	0.1	0 of 6		
Chicago - Oak St.	0.1 - 0.2	0.1	0 of 6		
				AVG. - 0.1 mg/l	
Chicago - 12th St.	0.1 - 0.2	0.1	0 of 6		
Chicago - 31st St.	0.1 - 0.2	0.1	0 of 6		
Chicago - 49th St.	0.1 - 0.2	0.1	0 of 4		
Chicago - 63rd St.	0.1 - 0.2	0.1	0 of 6		
Chicago - 76th St.	0.1 - 0.2	0.1	0 of 6		
Chicago - 100th St.	0.1 - 0.2	0.2	0 of 6		

Offshore Stations

The range of fluoride concentrations at the offshore stations was from 0.1 to 0.2 mg/l at all three depths. The averages ranged from 0.2 mg/l at the surface stations to 0.1 mg/l at the mid-depth and bottom stations. The average of all 65 lake samples was 0.1 mg/l

Water Plants

The maximum fluoride concentrations at the water plants ranged from 0.2 to 0.9 mg/l. These values were within the standard. Individual plant averages ranged from 0.1 to 0.3 mg/l. For all plants, the average concentration was 0.2 mg/l (Table 19).

Calumet Harbor

The maximum fluoride concentrations recorded within Calumet Harbor were 0.2 mg/l at the State Line station and 0.3 mg/l at the Calumet River Mouth station. These concentrations were within the standard. The average of eight samples was 0.2 mg/l (Table 19).

Table 19. Fluoride concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	0.1 - 0.2	0.2	11
Waukegan	0.1 - 0.9	0.2	12
North Chicago	0.1 - 0.2	0.1	10
Lake Forest	0.1 - 0.6	0.3	8
Highland Park	0.1 - 0.2	0.1	12
Glencoe	0.1 - 0.2	0.1	12
Winnetka	0.1 - 0.8	0.2	11
Kenilworth	0.1 - 0.2	0.1	12
Wilmette	0.1 - 0.6	0.2	12
Evanston	0.1 - 0.2	0.1	12
Chicago Central	0.1 - 0.2	0.1	12
Chicago South	0.1 - 0.3	0.2	12
CALUMET HARBOR			
State Line	0.1 - 0.2	0.1	4
Mouth, Calumet River	0.2 - 0.3	0.2	4

PHENOL

Phenols are associated with industrial wastes from coal distillation processes and the manufacture of plastics, dyes and disinfectants. In relatively small concentrations, they can cause taste and odor problems in public water supplies. The toxicity to aquatic life becomes a problem at somewhat higher concentrations. Therefore, there are separate standards for phenol in surface waters and for water at the point from which it is drawn for public water supply.

Shore Water

Phenol was detected in 17 of the 389 shore water samples, and one of those detections exceeded the standard. All but two of the detections ranged from 0.005 to 0.007 mg/l. At Waukegan's North Beach, however, concentrations of 0.029 and 0.900 mg/l were recorded.

A total of 63 surface, mid-depth and bottom samples were analyzed for phenols in 1973. Measurable concentrations were not found at any of the offshore stations.

Water Plants

At the water plants phenols were found in measurable concentrations in six of 136 samples. Three samples, with values of 0.003, 0.007 and 0.013 mg/l, were recorded at the Waukegan water plant. Other positive values were collected at the North Chicago (0.002 mg/l), Winnetka (0.005 mg/l) and Wilmette (0.007 mg/l) water plants. All of these concentrations exceeded the standard.

Calumet Harbor

Measurable concentrations of phenols were not found in eight samples collected in Calumet Harbor.

SULFATE

A common constituent of many natural waters, sulfates may be present in industrial and domestic wastes. Several of the sewage treatment plants tributary to Lake Michigan are using aluminum sulfate to reduce the concentrations of phosphorus in their effluents.

Shore Water

The average concentration of sulfate in the shore water was 17 mg/l. A very slight regional variation was evident. Overall, 3% of the samples analyzed exceeded the standard. Violations were more frequent in the samples from Lake county (5%) than in those from Cook county (1%), (Table 20).

Table 20. Sulfate concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

Standard: 24.0 mg/l					
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD		REGIONAL COMPARISON
Winthrop Harbor	10 - 25	18	1 of 13	8%	12 LAKE COUNTY STATIONS 7 of 149 (5%) SAMPLES EXCEEDED STANDARD AVG.-18 mg/l
Zion	10 - 23	18	0 of 13	0%	
Illinois Beach State Pk.	10 - 25	18	1 of 13	8%	
Waukegan North	9 - 150	30	3 of 13	23%	
Waukegan Central	9 - 23	17	0 of 13	0%	
Illinois Beach State Pk.					
North Chicago	11 - 24	18	0 of 13	0%	
Lake Bluff	9 - 23	16	0 of 13	0%	
Lake Forest	9 - 23	16	0 of 13	0%	
Highwood	10 - 23	17	0 of 13	0%	
Highland Park - Park Ave.	10 - 24	17	0 of 13	0%	19 COOK COUNTY STATIONS 3 of 239 (1%) SAMPLES EXCEEDED STANDARD AVG.-16 mg/l
Highland Park - Ravine Dr.	11 - 25	19	1 of 6	17%	
Highland Park - Cary Ave.	7 - 30	18	1 of 13	8%	
Glencoe	5 - 22	17	0 of 13	0%	
Winnetka	10 - 26	16	0 of 13	0%	
Kenilworth	10 - 22	16	0 of 11	0%	
Wilmette	10 - 25	17	1 of 13	8%	
Evanston - Dempster St.	9 - 25	17	1 of 13	8%	
Evanston - Elliot Pk.	11 - 23	16	0 of 13	0%	
Chicago - Touhy Ave.	10 - 24	16	0 of 13	0%	
Chicago - Loyola Pk.	10 - 23	16	0 of 13	0%	ALL 31 ILLINOIS STATIONS 10 of 388 (3%) SAMPLES EXCEEDED STANDARD AVG.-17 mg/l
Chicago - Bryn Mawr Ave.	10 - 22	16	0 of 12	0%	
Chicago - Foster Ave.	10 - 22	17	0 of 13	0%	
Chicago - Montross Ave.	10 - 22	16	0 of 13	0%	
Chicago - North Ave.	10 - 23	16	0 of 13	0%	
Chicago - Oak St.	10 - 22	16	0 of 12	0%	
Chicago - 12th St.	10 - 22	17	0 of 12	0%	
Chicago - 31st St.	11 - 25	17	0 of 13	0%	
Chicago - 49th St.	10 - 23	16	0 of 10	0%	
Chicago - 63rd St.	10 - 24	17	0 of 13	0%	
Chicago - 76th St.	10 - 24	17	0 of 13	0%	
Chicago - 100th St.	11 - 25	18	1 of 13	8%	

Offshore Stations

Sulfate concentrations were slightly higher at the surface stations than at either the mid-depth or bottom stations. For the year these concentrations ranged from 7 to 26 mg/l at the surface stations, 8 to 20 mg/l at the mid-depth stations and 7 to 20 mg/l at the bottom stations. Corresponding annual averages were 14, 13 and 12 mg/l. The average of all 65 samples was 13 mg/l. One surface sample collected at the Lake Bluff station had a sulfate concentration of 26 mg/l (Table 21).

Table 21. Sulfate concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

Standard: 24 mg/l

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Illinois - Wisconsin State Line	17 - 21	19	17 - 17	17	14 - 14	14
Waukegan	12 - 17	14	10 - 16	13	10 - 10	10
Lake Bluff	10 - 26	19	10 - 19	14	9 - 10	10
Highland Park	10 - 19	15	8 - 10	9	8 - 9	8
Wilmette	8 - 18	12	8 - 17	12	7 - 8	8
Chicago - Montrose Harbor	8 - 19	13	9 - 18	13	7 - 18	12
Chicago - Burnham Harbor	7 - 19	12	9 - 20	14	9 - 19	14
Illinois - Indiana State Line	8 - 20	12	8 - 20	13	9 - 20	14

Water Plants

The maximum sulfate concentrations ranged from 21 to 31 mg/l. Two of 136 samples analyzed had sulfate concentrations above 24 mg/l. For all plants the average was 17 mg/l (Table 22).

Calumet Harbor

Sulfate concentrations were within the standard in 1973. Maximum values were 20 and 24 mg/l at the State Line and Calumet River Mouth stations, respectively. The average of all samples was 14 mg/l (Table 22).

Table 22. Sulfate concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

Standard: 24.0 mg/l			
SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	NUMBER OF SAMPLES EXCEEDING STANDARD
WATER PLANTS			
Zion-Benton	10 - 31	19	1 of 11
Waukegan	12 - 28	19	1 of 12
North Chicago	9 - 22	16	0 of 10
Lake Forest	12 - 24	18	0 of 8
Highland Park	10 - 22	18	0 of 12
Glencoe	10 - 22	17	0 of 12
Winnetka	8 - 23	16	0 of 11
Kenilworth	9 - 22	17	0 of 12
Wilmette	9 - 24	17	0 of 12
Evanston	8 - 21	17	0 of 12
Chicago Central	8 - 23	16	0 of 12
Chicago South	8 - 23	16	0 of 12
CALUMET HARBOR			
State Line	9 - 20	13	0 of 4
Mouth, Calumet River	10 - 24	15	0 of 4

TOTAL PHOSPHORUS (as P)

Phosphorus is found in domestic sewage, some industrial wastes and in drainage from agricultural areas. It is considered to be one of the nutrients responsible for excessive algae growth. An effluent standard for waste discharges to Lake Michigan has resulted in the interim use of chemicals to reduce the phosphorus content of sewage plant effluents.

Shore Water

In 1973 unfiltered samples were analyzed. The average concentration of phosphorus in the shore water was 0.043 mg/l. There was some regional variation with the Lake county stations averaging 0.055 mg/l as compared to 0.036 mg/l at the Cook county stations. Overall, 93% of the samples collected exceeded the standard. Because the value specified in the standard is low in comparison to the concentrations detected in the shore water, the per cent of violations did not vary greatly from station to station (Table 23).

Table 23. Total phosphorus concentrations in Lake Michigan shore water in 1973. Concentrations are expressed in mg/l.

Standard: 0.007 mg/l					
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	0.003 - 0.105	0.043	13 of 13 100%	12 LAKE COUNTY STATIONS	
Zion	0.012 - 0.100	0.046	13 of 13 100%		
Illinois Beach State Park	0.000 - 0.250	0.058	11 of 13 85%		
Waukegan North	0.025 - 0.295	0.070	13 of 13 100%		
Waukegan Central	0.000 - 0.180	0.042	11 of 12 92%	143 of 147 (97%) SAMPLES EXCEEDED STANDARD	
North Chicago	0.010 - 0.120	0.061	13 of 13 100%		
Lake Bluff	0.010 - 0.160	0.059	13 of 13 100%		
Lake Forest	0.008 - 0.085	0.041	12 of 12 100%		
Highwood	0.004 - 0.125	0.057	12 of 13 92%	AVG.-0.055 mg/l	ALL 31 ILLINOIS STATIONS
Highland Park - Park Ave.	0.014 - 0.110	0.063	13 of 13 100%		
Highland Park - Ravine Dr.	0.010 - 0.110	0.055	6 of 6 100%		
Highland Park - Cary Ave.	0.015 - 0.315	0.068	13 of 13 100%		
Glencoe	0.012 - 0.100	0.043	13 of 13 100%	19 COOK COUNTY STATIONS	357 of 382 (93%) SAMPLES EXCEEDED STANDARD
Winnetka	0.010 - 0.200	0.045	13 of 13 100%		
Kenilworth	0.012 - 0.075	0.038	10 of 10 100%		
Wilmette	0.013 - 0.150	0.049	12 of 12 100%		
Evanston - Dempster St.	0.015 - 0.087	0.041	12 of 12 100%	214 of 235 (91%) SAMPLES EXCEEDED STANDARD	AVG.-0.043 mg/l
Evanston - Elliot Pk.	0.005 - 0.095	0.038	11 of 12 92%		
Chicago - Touhy Ave.	0.015 - 0.100	0.041	13 of 13 100%		
Chicago - Loyola Pk.	0.010 - 0.075	0.038	13 of 13 100%		
Chicago - Bryn Mawr Ave.	0.000 - 0.075	0.024	10 of 12 83%	AVG.-0.036 mg/l	
Chicago - Foster Ave.	0.000 - 0.087	0.034	11 of 13 85%		
Chicago - Montrose Ave.	0.007 - 0.270	0.062	12 of 13 92%		
Chicago - North Ave.	0.000 - 0.065	0.026	11 of 13 85%		
Chicago - Oak St.	0.000 - 0.045	0.017	8 of 12 67%		
Chicago - 12th St.	0.000 - 0.052	0.020	10 of 12 83%		
Chicago - 31st St.	0.000 - 0.085	0.030	11 of 13 85%		
Chicago - 49th St.	0.000 - 0.042	0.019	8 of 10 80%		
Chicago - 63rd St.	0.006 - 0.140	0.039	12 of 13 92%		
Chicago - 76th St.	0.004 - 0.275	0.045	11 of 13 85%		
Chicago - 100th St.	0.010 - 0.075	0.033	13 of 13 100%		

Offshore Stations

The maximum phosphorus concentrations ranged from 0.005 to 0.150 mg/l at the surface stations, 0.005 to 0.040 mg/l at the mid-depth stations and 0.005 to 0.035 mg/l at the bottom stations. Highest concentrations of phosphorus in surface and mid-depth samples were found at the northernmost station. From surface to bottom the annual averages were 0.014, 0.007 and 0.009 mg/l. The average of all 55 samples was 0.010 mg/l. A total of 21.4% of the surface samples had phosphorus concentrations higher than 0.007 mg/l. Comparable figures for the mid-depth and bottoms stations were 23 and 32%. Overall, 25% of the samples exceeded the standard (Table 24).

Table 24. Phosphorus concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.
Illinois - Wisconsin State Line	0.007 - 0.150	0.078	0.007 - 0.040	0.024	0.010 - 0.020	0.015
Waukegan	---	---	0.020 - 0.025	0.022	0.007 - 0.007	0.007
Lake Bluff	0.005 - 0.010	0.008	0.000 - 0.007	0.004	0.000 - 0.005	0.002
Highland Park	---	---	0.000 - 0.005	0.002	0.005 - 0.007	0.006
Wilmette	0.000 - 0.010	0.006	0.000 - 0.010	0.006	0.000 - 0.007	0.004
Chicago - Montrose Harbor	0.000 - 0.005	0.002	0.000 - 0.007	0.002	0.000 - 0.020	0.010
Chicago - Burnham Harbor	---	---	0.000 - 0.007	0.003	0.000 - 0.035	0.018
Illinois - Indiana State Line	0.000 - 0.005	0.003	0.000 - 0.015	0.007	0.000 - 0.005	0.002

Water Plants

Maximum phosphorus concentrations ranged from 0.035 to 1.045 mg/l. For all plants the averages ranged from 0.009 to 0.122 mg/l. The annual average for all samples was 0.036 mg/l. Of the 136 samples analyzed for phosphorus, 64% had concentrations higher than 0.007 mg/l. Samples exceeding the standard ranged from 33 to 91% of samples collected (Table 25).

Calumet Harbor

The phosphorus concentration in 62% of the samples exceeded 0.007 mg/l in 1973. Concentrations ranged from 0.000 to 0.022 mg/l at the State Line station and from 0.000 to 0.020 mg/l at the Calumet River Mouth station. For all samples the average concentration was 0.012 mg/l (Table 25).

Table 25. Phosphorus concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	Standard: 0.007 mg/l		
	RANGE mg/l	AVERAGE mg/l	NUMBER OF SAMPLES EXCEEDING STANDARD
WATER PLANTS			
Zion-Benton	0.000 - 0.050	0.022	10 of 11
Waukegan	0.000 - 0.325	0.051	8 of 12
North Chicago	0.000 - 0.115	0.022	5 of 10
Lake Forest	0.000 - 0.135	0.048	6 of 8
Highland Park	0.000 - 0.190	0.038	6 of 12
Glencoe	0.000 - 0.100	0.021	8 of 12
Winnetka	0.000 - 0.130	0.031	7 of 11
Kenilworth	0.000 - 1.045	0.122	8 of 12
Wilmette	0.000 - 0.080	0.028	10 of 12
Evanston	0.000 - 0.130	0.035	10 of 12
Chicago Central	0.000 - 0.035	0.009	5 of 12
Chicago South	0.000 - 0.040	0.009	4 of 12
CALUMET HARBOR			
State Line	0.000 - 0.022	0.010	2 of 4
Mouth, Calumet River	0.000 - 0.020	0.014	3 of 4

TOTAL DISSOLVED SOLIDS

The capacity to convey an electrical current through a quantity of water has been shown to be related to the concentration of dissolved minerals in the water. By using the relatively quick analysis for specific conductance and multiplying by a conversion factor (0.6 for Lake Michigan water) a close approximation of the dissolved solids is obtained. The results of this test are reported out to tens place accuracy.

Table 26. Total dissolved solids concentrations in Lake Michigan shore water during 1973. Concentrations expressed in mg/l.

Standard: 180.0 mg/l					
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	160 - 190	170	1 of 13 8%	12 LAKE COUNTY STATIONS	
Zion	160 - 190	170	1 of 13 8%		
Illinois Beach State Park	170 - 190	170	1 of 13 8%		
Waukegan North	170 - 500	210	5 of 13 38%		
Waukegan Central	160 - 190	170	1 of 13 8%		
North Chicago	170 - 190	180	1 of 13 8%	13 of 149 (9%) SAMPLES EXCEEDED STANDARD	ALL 31 ILLINOIS STATIONS
Lake Bluff	170 - 180	170	0 of 13 0%		
Lake Forest	160 - 180	170	0 of 13 0%		
Highwood	170 - 180	170	0 of 13 0%		
Highland Park - Park Ave.	170 - 190	170	1 of 13 8%		
Highland Park - Ravine Dr.	170 - 210	180	1 of 6 17%	AVG.-180 mg/l	17 of 387 (4%) SAMPLES EXCEEDED STANDARD
Highland Park - Cary Ave.	170 - 260	180	1 of 13 8%		
Glencoe	160 - 190	170	1 of 13 8%		
Winnetka	160 - 180	170	0 of 13 0%		
Kenilworth	170 - 170	170	0 of 11 0%		
Wilmette	160 - 170	170	0 of 13 0%	19 COOK COUNTY STATIONS	AVG.-170 mg/l
Evanston Dempster St.	170 - 170	170	0 of 13 0%		
Evenston Elliot Pk.	160 - 170	170	0 of 13 0%		
Chicago - Touhy Ave.	150 - 170	170	0 of 13 0%		
Chicago - Loyola Pk.	160 - 170	170	0 of 13 0%		
Chicago - Bryn Mawr Ave.	170 - 170	170	0 of 12 0%	4 of 238 (2%) SAMPLES EXCEEDED STANDARD	
Chicago - Foster Ave.	170 - 170	170	0 of 13 0%		
Chicago - Montrose Ave.	160 - 220	170	1 of 13 8%		
Chicago - North Ave.	160 - 180	170	0 of 13 0%		
Chicago - Oak St.	160 - 170	170	0 of 12 0%		
Chicago - 12th St.	170 - 180	170	0 of 12 0%	AVG.-170 mg/l	
Chicago - 31st St.	160 - 250	180	1 of 13 8%		
Chicago - 49th St.	160 - 180	170	0 of 9 0%		
Chicago - 63rd St.	160 - 200	170	1 of 13 8%		
Chicago - 76th St.	160 - 180	170	0 of 13 0%		
Chicago - 100th St.	160 - 180	170	0 of 13 0%		

Shore Water

The average concentration of dissolved solids in the shore water was 170 mg/l. Overall, 4% of the samples collected exceeded the standard. Regionally, 9% of the Lake county samples, as compared to 2% of the Cook county samples, were in violation (Table 26).

Offshore Stations

There were no significant differences in total dissolved solids at the three sampling depths. Concentrations ranged from 160 to 170 mg/l and averaged 160 mg/l (Table 27).

Water Plants

Maximum concentrations of total dissolved solids at the water plants ranged from 170 to 180 mg/l; the average at all 12 plants was 170 mg/l (Table 28).

Calumet Harbor

One sample from the Calumet River Mouth station, with a value of 190 mg/l, exceeded the standard for total dissolved solids. The average of seven harbor samples was 180 mg/l (Table 28).

Table 27. Total dissolved solids concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.
Illinois - Wisconsin State Line	160 - 170	160	160 - 170	160	160 - 160	160
Waukegan	170 - 170	170	160 - 170	160	170 - 170	170
Lake Bluff	160 - 170	160	160 - 170	160	160 - 170	160
Highland Park	160 - 170	160	160 - 170	160	160 - 170	160
Wilmette	170 - 170	170	160 - 170	170	160 - 170	170
Chicago - Montrose Harbor	160 - 170	170	160 - 170	170	160 - 170	160
Chicago - Burnham Harbor	160 - 170	160	160 - 170	160	160 - 170	160
Illinois - Indiana State Line	160 - 170	160	160 - 170	160	170 - 170	170

Table 28. Total dissolved solids concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

Standard: 180.0 mg/l			
SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	NUMBER OF SAMPLES EXCEEDING STANDARD
WATER PLANTS			
Zion-Benton	160 - 180	170	0 of 11
Waukegan	160 - 170	170	0 of 12
North Chicago	160 - 170	170	0 of 10
Lake Forest	170 - 170	170	0 of 8
Highland Park	160 - 180	170	0 of 12
Glencoe	160 - 170	170	0 of 12
Winnetka	160 - 180	170	0 of 11
Kenilworth	160 - 180	170	0 of 12
Wilmette	160 - 180	170	0 of 12
Evanston	160 - 170	170	0 of 12
Chicago Central	160 - 170	170	0 of 12
Chicago South	160 - 170	170	0 of 12
CALUMET HARBOR			
State Line	170 - 170	170	0 of 3
Mouth, Calumet River	170 - 190	180	1 of 4

RADIOACTIVITY

In addition to naturally occurring background radiation, radioactive substances may enter the aquatic environment from atomic energy installations, from users of radionuclides, through the activities associated with uranium ore mining and as atmospheric fall-out.

There is no standard for gross alpha emissions. Gross beta values may not be higher than 100 pCi/l.

Shore Water

Samples were collected from each of the thirty-one stations on six different occasions. Alpha concentrations averaged 0.5 pCi/l. The average gross beta concentration was 4.4 pCi/l (Table 29).

Table 29. Gross alpha and beta emissions recorded in Lake Michigan shore water in 1973. Values are in pCi/l.

SAMPLING LOCATION	GROSS ALPHA		GROSS BETA		SAMPLES ANALYZED
	RANGE	AVG.	RANGE	AVG.	
Winthrop Harbor	0.0 - 0.9	0.3	2.3 - 6.0	3.9	6
Zion	0.0 - 0.7	0.3	2.7 - 7.1	5.0	6
Illinois Beach State Park	0.1 - 1.1	0.4	1.6 - 6.8	3.8	6
Waukegan North	0.2 - 1.0	0.6	1.6 - 5.2	3.6	6
Waukegan Central	0.1 - 0.9	0.5	0.1 - 9.5	4.4	6
North Chicago	0.1 - 1.0	0.5	2.8 - 9.9	5.3	6
Lake Bluff	0.2 - 2.4	0.9	1.2 - 12.7	5.7	6
Lake Forest	0.0 - 1.4	0.5	2.9 - 10.3	5.2	6
Highwood	0.2 - 3.8	0.9	2.4 - 10.6	5.9	6
Highland Park - Park Ave.	0.1 - 1.8	0.7	0.4 - 10.3	5.0	6
Highland Park - Ravine Dr.	0.2 - 0.3	0.3	1.1 - 5.7	3.9	3
Highland Park - Cary Ave.	0.0 - 1.9	0.6	3.4 - 13.1	5.8	6
Glencoe	0.2 - 2.4	0.7	1.0 - 11.4	4.7	6
Winnetka	0.2 - 1.4	0.5	3.2 - 8.6	4.8	6
Kenilworth	0.2 - 0.6	0.3	1.6 - 7.3	4.0	5
Wilmette	0.5 - 5.8	1.4	2.2 - 8.7	6.6	6
Evanston Demp. St.	0.0 - 0.3	0.2	2.2 - 8.7	4.0	6
Evanston Elliot Pk.	0.0 - 0.8	0.4	0.9 - 8.3	3.8	6
Chicago - Touhy Ave.	0.1 - 0.9	0.3	0.2 - 6.9	3.8	6
Chicago - Loyola Pk.	0.1 - 0.7	0.4	0.0 - 6.0	3.2	6
Chicago - Bryn Mawr. Ave.	0.0 - 0.3	0.2	1.5 - 7.2	4.2	6
Chicago - Foster Ave.	0.0 - 1.0	0.4	1.4 - 8.1	4.6	6
Chicago - Montrose Ave.	0.0 - 0.8	0.4	0.9 - 7.7	3.4	6
Chicago - North Ave.	0.0 - 0.9	0.4	2.0 - 8.7	4.6	6
Chicago - Oak St.	0.0 - 1.0	0.4	0.1 - 7.2	4.1	6
Chicago - 12th St.	0.0 - 0.6	0.4	1.4 - 8.3	4.6	6
Chicago - 31st St.	0.0 - 0.7	0.2	0.4 - 7.8	3.4	6
Chicago - 49th St.	0.1 - 1.0	0.5	2.0 - 6.0	4.0	4
Chicago - 63rd St.	0.0 - 0.8	0.3	2.0 - 6.6	4.0	6
Chicago - 76th St.	0.0 - 0.9	0.4	0.0 - 8.3	3.2	6
Chicago - 100th St.	0.0 - 1.0	0.3	2.4 - 8.2	5.3	6

Offshore Stations

At the offshore stations gross alpha values ranged from 0.0 to 2.5 pCi/l at the surface stations and from 0.0 to 0.8 pCi/l at the mid-depth and bottom stations. Corresponding averages were 0.3, 0.2 and 0.2 pCi/l. The average of 60 offshore samples was 0.2 pCi/l.

Gross beta values ranged from 0.0 to 5.0 pCi/l at the surface and mid-depth stations and from 0.9 to 5.1 pCi/l at the bottom stations. The corresponding averages were 2.4, 2.6 and 2.3 pCi/l. The average of 60 samples was 2.4 pCi/l.

Water Plants

At the water plants maximum gross alpha emissions ranged from 0.8 to 2.3 pCi/l. Averages by plant ranged from 0.4 to 0.6 pCi/l. The average of all samples analyzed was 0.5 pCi/l.

The maximum gross beta emissions ranged from 6.8 to 22.9 pCi/l. Averages by plant ranged from 4.1 to 7.3 pCi/l. The average of all samples was 5.1 pCi/l (Table 30).

Table 30. Gross alpha and beta emissions recorded at municipal water filtration plants in 1973. Values are in pCi/l.

Standard: Gross Alpha No Standard Gross Beta 100 pCi/l					
SAMPLING LOCATION	GROSS ALPHA		GROSS BETA		SAMPLES ANALYZED
	RANGE	AVG.	RANGE	AVG.	
WATER PLANTS					
Zion-Benton	0.0 - 1.1	0.5	2.1 - 9.4	5.2	11
Waukegan	0.0 - 1.2	0.5	0.6 - 8.4	4.1	12
North Chicago	0.2 - 1.1	0.5	2.9 - 8.5	4.9	10
Lake Forest	0.1 - 1.9	0.5	2.3 - 8.7	5.3	7
Highland Park	0.0 - 1.9	0.5	2.4 - 8.0	5.2	12
Glencoe	0.0 - 0.9	0.4	1.6 - 9.0	4.7	12
Winnetka	0.1 - 0.8	0.4	1.0 - 6.8	5.2	11
Kenilworth	0.0 - 1.2	0.5	1.8 - 8.6	5.0	12
Wilmette	0.1 - 2.3	0.6	2.9 - 22.9	7.3	12
Evanston	0.2 - 1.3	0.6	2.4 - 8.3	5.3	12
Chicago Central	0.0 - 0.8	0.4	1.4 - 6.9	4.6	12
Chicago South	0.0 - 1.4	0.5	1.2 - 7.8	4.7	11

Calumet Harbor

Four water samples from each Calumet Harbor station were analyzed for gross alpha and gross beta in 1973. Gross alpha values at the State Line station ranged from 0.0 to 0.6 pCi/l, with an average of 0.2 pCi/l. Gross beta values ranged from 0.0 to 3.5 pCi/l, with an average of 2.6 pCi/l.

At the Calumet River Mouth station gross alpha values ranged from 0.0 to 0.2 pCi/l, with an average of 0.2 pCi/l. Gross beta values ranged from 0.8 to 6.2 pCi/l, with an average of 3.2 pCi/l.

FECAL COLIFORM

The fecal coliform test is employed to identify a variety of bacteria which are commonly found in the intestines and fecal discharges of warm blooded animals. These particular bacteria are not generally considered pathogenic, but their association with fecal material makes them useful indicators of the probable presence of disease producing organisms.

The longevity of the fecal coliform bacteria in the unfavorable environment of water is limited, and only organisms of relatively recent passage are detected in the analysis. This fact, coupled with the virtual absence of live-stock in the Illinois watershed to Lake Michigan, makes the test a reliable indicator of recent sewage contamination.

The standard for bacteria incorporates a calculation called the geometric mean. Just as the arithmetic mean is the average of a group of numbers, the geometric mean is the average of the logarithms of a group of numbers. It statistically reduces the influence of several very large values on a series of relatively small numbers.

Example: A station sampled daily for 100 days showed bacterial concentrations of 1/100 ml for ninety-nine of the samples. On one day, a count of 10,000/100 ml was detected. That one high count causes the average to be 100/100 ml. The geometric mean, however, is 1/100 ml and is a more accurate representation of the general condition of this station.

Shore Water

The annual geometric mean for fecal coliform in the shore water was 11/100 ml. The geometric mean for the stations in Lake county was more than four times greater than that for the Cook county stations. Six of the thirty-one shore water stations had annual geometric means in excess of 20/100 ml (Table 31).

Table 31. Fecal coliform density in Lake Michigan shore water. Counts are expressed as the number per 100 ml.

Standard: Geometric mean 20/100 ml.			
SAMPLING LOCATION	SAMPLES ANALYZED	RANGE NUMBER/100 ml.	GEOMETRIC MEAN NUMBER/100 ml.
Winthrop Harbor	12	1 - 2000	9
Zion	13	1 - 450	13
Illinois Beach State Park	13	1 - 700	18
Waukegan North	13	2 - 220	19
Waukegan Central	13	1 - 500	19
North Chicago	13	1 - 230	14
Lake Bluff	13	1 - 780	22
Lake Forest	13	1 - 190	13
Highwood	13	1 - 4300	163
Highland Park - Park Avenue	13	1 - 3000	276
Highland Park - Ravine Drive	5	14 - 108	36
Highland Park - Cary Avenue	13	1 - 570	23
Glencoe	13	1 - 250	33
Winnetka	13	1 - 280	11
Kenilworth	10	1 - 190	4
Wilmette	12	1 - 54	4
Evenston Demp. St.	13	1 - 120	8
Evenston Elliot Pk.	13	1 - 200	6
Chicago - Touhy Ave.	13	1 - 350	6
Chicago - Loyole Pk.	13	1 - 220	4
Chicago - Bryn Mawr Ave.	12	1 - 52	4
Chicago - Foster Ave.	13	1 - 80	7
Chicago - Montrose Ave.	13	1 - 590	8
Chicago - North Ave.	13	1 - 400	9
Chicago - Oak St.	12	1 - 520	6
Chicago - 12th St.	12	1 - 300	5
Chicago - 31st St.	13	1 - 24	4
Chicago - 49th St.	10	1 - 4	2
Chicago - 63rd St.	13	1 - 90	3
Chicago - 76th St.	13	1 - 270	9
Chicago - 100th St.	13	1 - 510	16

Offshore Stations

Fecal coliform geometric means at the three depths were 2, 1 and 2/100 ml from surface to bottom. For all samples (65) the geometric mean was 2/100 ml. The maximum counts were 5/100 ml at the surface and mid-depth stations and 280/100 ml at the bottom stations (Table 32).

Table 32. Fecal coliform densities recorded 5-miles offshore in Lake Michigan in 1973. Counts are expressed as the number per 100 ml.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	GEOM. MEAN
Illinois - Wisconsin State Line	1 - 5	2	1 - 5	2	1 - 5	2
Waukegan	1 - 1	1	1 - 1	1	1 - 1	1
Lake Bluff	1 - 1	1	1 - 1	1	1 - 1	1
Highland Park	1 - 1	1	1 - 1	1	1 - 1	1
Wilmette	1 - 1	1	1 - 1	1	1 - 280	6
Chicago - Montrose Harbor	2 - 5	3	1 - 5	1	1 - 10	2
Chicago - Burnham Harbor	1 - 5	3	1 - 5	2	1 - 5	2
Illinois - Indiana State Line	1 - 5	2	1 - 5	2	1 - 5	2

Water Plants

Geometric mean counts of fecal coliform ranged from 1 to 4/100 ml in 1973. For all plants the geometric mean was 2/100 ml. The maximum fecal coliform counts ranged from 5 to 370/100 ml (Table 33).

Calumet Harbor

The geometric means at the State Line and Calumet River Mouth stations were 7 and 53/100 ml, respectively. This was based on four samples each from the two harbor stations. The geometric mean of all samples was 19/100 ml (Table 33).

Table 33. Fecal coliform densities recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Counts are expressed as the number per 100 ml.

Standard: Geometric mean 20/100 ml			
SAMPLING LOCATION	RANGE	GEOMETRIC MEAN	SAMPLES ANALYZED
WATER PLANTS			
Zion - Benton	1 - 300	3	9
Waukegan	1 - 5	1	10
North Chicago	1 - 370	3	9
Lake Forest	1 - 32	2	6
Highland Park	1 - 70	4	9
Glencoe	1 - 24	2	9
Winnetka	1 - 132	2	9
Kenilworth	1 - 42	3	9
Wilmette	1 - 100	2	10
Evanston	1 - 200	3	10
Chicago Central	1 - 5	1	10
Chicago South	1 - 5	1	10
CALUMET HARBOR			
State Line	5 - 10	7	4
Mouth, Calumet Harbor	10 - 700	53	4

PLANKTON

The free living, mostly microscopic organisms that are suspended in water and depend primarily upon currents for their dispersal are called plankton. Certain varieties clog sand filters, resulting in increased costs of water treatment. Other varieties are occasionally responsible for taste and odor problems in drinking water.

There is no standard for plankton concentrations, but samples were routinely analyzed to provide background data for monitoring lake eutrophication. The method involved microscopically inspecting the samples, using a Palmer cell, at 450 power.

Shore Water

The annual average for plankton concentrations in the shore water was 3600/ml. There was a marked regional variation, with almost all of the Lake county stations having counts below the average and almost all the Cook county stations above (Table 34).

Table 34. Total plankton counts in Lake Michigan shore water during 1973. Counts are expressed as the number per ml.

SAMPLING LOCATION	RANGE NUMBER/ml	AVERAGE NUMBER/ml	SAMPLES ANALYZED	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	1100 - 7900	3800	13	12 LAKE COUNTY STATIONS	
Zion	1100 - 5000	3200	13		
Illinois Beach State Park	1500 - 6300	3800	13		
Waukegan North	900 - 5300	2600	13		
Waukegan Central	1200 - 5100	2900	13		
North Chicago	1200 - 5100	2900	13		
Lake Bluff	800 - 4200	2400	13		
Lake Forest	1200 - 4500	2300	13		
Highwood	1000 - 4400	2700	13		
Highland Park - Park Ave.	1700 - 4300	2700	13		
Highland Park - Ravine Dr.	1000 - 3200	2200	6	19 COOK COUNTY STATIONS	ALL 31 ILLINOIS STATIONS
Highland Park - Cary Ave.	1200 - 3900	2800	13		
Glencoe	1600 - 4400	2800	13		
Winnetka	1500 - 6400	3000	13		
Kenilworth	2300 - 6700	4000	10		
Wilmette	2300 - 9500	4000	12		
Evanston Demp. St.	1800 - 8300	4400	12		
Evanston Elliot Pk.	2100 - 13300	5500	13		
Chicago - Touhy Ave.	1500 - 8400	4300	13		
Chicago - Loyola Pk.	1700 - 11900	4600	13		
Chicago - Bryn Mawr Ave.	2200 - 6500	3900	12	AVG. CONC. 4100/ml.	AVG. CONC. 3600/ml.
Chicago - Foster Ave.	1300 - 10900	4200	13		
Chicago - Montrose Ave.	2300 - 7300	4100	13		
Chicago - North Ave.	2000 - 10700	4500	13		
Chicago - Oak St.	2700 - 8400	4300	10		
Chicago - 12th St.	1500 - 4700	3200	11		
Chicago - 31st St.	1500 - 6000	3800	13		
Chicago - 49th St.	1700 - 5900	3600	10		
Chicago - 63rd St.	2200 - 17000	5100	13		
Chicago - 76th St.	2000 - 8900	4200	13		
Chicago - 100th St.	2300 - 8900	4600	13		

Offshore Stations

At the offshore stations the maximum plankton counts ranged from 1,600 to 3,300/ml at the surface stations, 1,500 to 5,500/ml at the mid-depth stations and 1,700 to 5,500/ml at the bottom stations. Surface, mid-depth and bottom averages were 2,000, 2,200 and 2,600/ml, respectively and, for all samples, the plankton average was 2,300/ml (Table 35).

Table 35. Total plankton counts recorded 5-miles offshore in Lake Michigan in 1973. Counts are expressed as the number per ml.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.
Illinois - Wisconsin State Line	2,000 - 3,200	2,600	2,200 - 2,600	2,400	1,600 - 2,300	2,000
Waukegan	1,500 - 1,600	1,600	1,400 - 1,500	1,400	1,700 - 1,700	1,700
Lake Bluff	1,000 - 2,500	1,800	1,500 - 5,500	3,500	2,200 - 2,800	2,500
Highland Park	1,500 - 2,600	2,000	1,600 - 3,500	2,600	1,500 - 3,400	2,400
Wilmette	1,200 - 2,200	1,600	1,500 - 3,600	2,300	1,500 - 4,300	2,500
Chicago - Montrose Harbor	1,200 - 2,800	1,900	900 - 3,300	2,200	1,600 - 3,200	2,500
Chicago - Burnham Harbor	1,300 - 3,300	2,200	2,100 - 2,500	2,300	1,700 - 4,500	3,000
Illinois - Indiana State Line	1,700 - 2,200	2,000	1,200 - 1,800	1,500	2,000 - 5,500	3,200

Water Plants

At the water plants the maximum plankton population counts ranged from 3,900 to 8,500/ml in 1973. By plant, the averages ranged from 2,300 to 3,300/ml. The average of all 136 samples was 2,700/ml (Table 36).

Calumet Harbor

The plankton counts ranged from 2,100 to 8,400/ml in Calumet Harbor. The average of eight plankton samples was 4,000/ml (Table 36).

Table 36. Total plankton counts recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Counts are expressed as the number per ml.

SAMPLING LOCATION	RANGE	AVERAGE	SAMPLES ANALYZED
WATER PLANTS			
Zion - Benton	2,000 - 4,500	2,800	11
Waukegan	1,500 - 4,600	2,600	12
North Chicago	1,100 - 3,900	2,400	10
Lake Forest	1,800 - 4,400	2,700	8
Highland Park	2,000 - 4,600	3,000	12
Glencoe	1,700 - 4,200	2,700	12
Winnetka	200 - 3,900	2,300	11
Kenilworth	200 - 4,300	2,600	12
Wilmette	600 - 8,500	2,900	12
Evanston	2,000 - 4,900	3,300	12
Chicago Central	1,300 - 4,000	2,400	12
Chicago South	1,200 - 6,000	3,000	12
CALUMET HARBOR			
State Line	2,100 - 5,200	3,600	4
Mouth, Calumet River	2,200 - 8,400	4,400	4

SECCHI DISC

From an esthetic standpoint minimum discoloration, low turbidity and high visibility are desirable attributes in any body of water. In the field, visibility is measured with the Secchi disc, which is a circular plate marked off into alternating black and white quadrants. The disc is lowered into the water until it becomes indistinguishable from its surroundings. The depth at which this occurs is recorded. The disc is then raised until it just becomes visible again and a second depth reading is obtained. These two readings are averaged to obtain a value which represents the practical limit of visibility.

Offshore Stations

At the offshore stations minimum visibilities ranged from 10 to 20 feet and maximum readings ranged from 12 to 24 feet. The lake-wide average was 17 feet (Table 37).

Calumet Harbor

Five Secchi disc readings were made in Calumet Harbor in 1973. These readings ranged from 5 to 7 feet at the State Line station and from 6 to 8 feet at the Calumet River Mouth station. Annual averages at these two stations were 6 and 7 feet, respectively.

Table 37. Secchi disc readings recorded 5-miles offshore in Lake Michigan in 1973. Values are expressed in feet.

SAMPLING LOCATION	RANGE	AVERAGE
Illinois-Wisconsin State Line	10 - 12	11
Waukegan	12 - 14	13
Lake Bluff	14 - 24	19
Highland Park	18 - 20	19
Wilmette	17 - 18	18
Chicago-Montrose Harbor	12 - 18	16
Chicago-Burnham Harbor	12 - 20	17
Illinois-Indiana State Line	20 - 24	22

NITRATE + NITRITE (as N)

Nitrate is a product of the natural process by which organic nitrogen is stabilized. Domestic sewage and agricultural application of fertilizer contribute nitrate to surface waters. High concentrations of nitrate in drinking water have been known to cause a blood deficiency in infants.

Shore Water

The average concentration of nitrate and nitrite was 0.2 mg/l in the shore water. The maximum range in the 388 samples analyzed was from 0.4 mg/l to 0.7 mg/l, well below the public water supply standard of 10 mg/l. There was no appreciable regional variation (Table 38).

Table 38. Nitrate and nitrite (as N) concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

Standard: 10.0 mg/l					
SAMPLING LOCATION	RANGE mg/l	AVERAGE CONCENTRATION mg/l	SAMPLES EXCEEDING STANDARD	REGIONAL COMPARISON	OVERALL RESULTS
Winthrop Harbor	0.1 - 0.5	0.2	0 of 13	12 LAKE COUNTY STATIONS	
Zion	0.1 - 0.5	0.2	0 of 13		
Illinois Beach State Park	0.1 - 0.6	0.2	0 of 13		
Waukegan North	0.1 - 0.6	0.2	0 of 13		
Waukegan Central	0.1 - 0.6	0.2	0 of 13	0 of 149	ALL 31 ILLINOIS STATIONS
North Chicago	0.1 - 0.5	0.3	0 of 13	SAMPLES EXCEEDED STANDARD	
Lake Bluff	0.0 - 0.4	0.2	0 of 13		
Lake Forest	0.0 - 0.4	0.2	0 of 13		
Highwood	0.1 - 0.5	0.2	0 of 13	AVG.-0.2 mg/l	0 of 388
Highland Park - Park Ave.	0.1 - 0.4	0.2	0 of 13		
Highland Park - Ravine Dr.	0.2 - 0.4	0.3	0 of 6		
Highland Park - Cary Ave.	0.1 - 0.7	0.2	0 of 13		
Glencoe	0.1 - 0.4	0.2	0 of 13	19 COOK COUNTY STATIONS	SAMPLES EXCEEDED STANDARD
Winnetka	0.1 - 0.5	0.2	0 of 13		
Kenilworth	0.1 - 0.4	0.2	0 of 11		
Wilmette	0.1 - 0.5	0.2	0 of 13		
Evanston Demp. St.	0.1 - 0.6	0.2	0 of 13	0 of 239	AVG.-0.2 mg/l
Evanston Elliot Pk.	0.1 - 0.4	0.2	0 of 13		
Chicago - Touhy Ave.	0.1 - 0.4	0.2	0 of 13		
Chicago - Loyola Pk.	0.1 - 0.4	0.2	0 of 13		
Chicago - Bryn Mawr Ave.	0.1 - 0.4	0.2	0 of 12	SAMPLES EXCEEDED STANDARD	
Chicago - Foster Ave.	0.1 - 0.4	0.2	0 of 13		
Chicago - Montrose Ave.	0.1 - 0.4	0.2	0 of 13		
Chicago - North Ave.	0.1 - 0.4	0.2	0 of 13		
Chicago - Oak St.	0.1 - 0.4	0.2	0 of 12	AVG.-0.2 mg/l	
Chicago - 12th St.	0.1 - 0.5	0.2	0 of 12		
Chicago - 31st St.	0.1 - 0.4	0.2	0 of 13		
Chicago - 49th St.	0.1 - 0.4	0.2	0 of 10		
Chicago - 63rd St.	0.1 - 0.4	0.2	0 of 13		
Chicago - 76th St.	0.1 - 0.4	0.2	0 of 13		
Chicago - 100th St.	0.1 - 0.5	0.2	0 of 13		

Offshore Stations

At the offshore stations the maximum concentrations at all three sampling depths ranged from 0.1 to 0.4 mg/l. The average of 65 lake samples was 0.2 mg/l (Table 39).

Table 39. Nitrate-nitrite (as N) concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	SURFACE		MID-DEPTH		BOTTOM	
	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.
Illinois - Wisconsin State Line	0.2 - 0.3	0.2	0.2 - 0.4	0.3	0.2 - 0.4	0.3
Waukegan	0.1 - 0.4	0.2	0.2 - 0.4	0.3	0.1 - 0.1	0.1
Lake Bluff	0.2 - 0.3	0.2	0.2 - 0.3	0.2	0.1 - 0.3	0.2
Highland Park	0.2 - 0.3	0.2	0.2 - 0.3	0.2	0.2 - 0.3	0.2
Wilmette	0.2 - 0.3	0.2	0.2 - 0.3	0.2	0.2 - 0.3	0.2
Chicago - Montrose Harbor	0.1 - 0.4	0.2	0.1 - 0.2	0.2	0.1 - 0.3	0.2
Chicago - Burnham Harbor	0.1 - 0.3	0.2	0.1 - 0.3	0.2	0.1 - 0.3	0.2
Illinois - Indiana State Line	0.1 - 0.3	0.2	0.1 - 0.3	0.2	0.1 - 0.1	0.1

Water Plants

The maximum nitrate-nitrite concentrations at the water plants ranged from 0.4 to 0.6 mg/l, which were well within the standard. Averages ranged from 0.2 to 0.4 mg/l. For all plants the average was 0.3 mg/l (Table 40).

Calumet Harbor

The maximum concentration in Calumet Harbor was 0.3 mg/l. This concentration was recorded in samples from both stations. The concentrations in seven samples ranged from 0.1 to 0.3 mg/l with an average of 0.2 mg/l (Table 40).

Table 40. Nitrate-nitrite (as N) concentrations recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	SAMPLES ANALYZED
WATER PLANTS			
Zion - Benton	0.1 - 0.6	0.3	11
Waukegan	0.1 - 0.6	0.3	12
North Chicago	0.1 - 0.6	0.3	10
Lake Forest	0.1 - 0.6	0.4	8
Highland Park	0.2 - 0.6	0.3	12
Glencoe	0.1 - 0.4	0.2	12
Winnetka	0.1 - 0.6	0.3	11
Kenilworth	0.1 - 0.5	0.3	12
Wilmette	0.1 - 0.6	0.3	12
Evanston	0.2 - 0.5	0.3	12
Chicago Central	0.1 - 0.6	0.3	12
Chicago South	0.1 - 0.6	0.3	12
CALUMET HARBOR			
State Line	0.2 - 0.3	0.2	4
Mouth, Calumet River	0.1 - 0.3	0.2	3

ALKALINITY

In the aquatic environment, alkalinity serves as a buffer to prevent any abrupt change in pH of the water which might otherwise affect fish and other aquatic organisms.

Offshore Stations

Alkalinity values ranged from 104 to 108 mg/l at all three depths. The average at each depth as well as the average of the 65 samples was 106 mg/l.

Water Plants

At the water plants alkalinity values ranged from 102 to 116 mg/l in 1973. Individual plant averages ranged from 106 to 109 mg/l. For all samples the average was 108 mg/l (Table 41).

Calumet Harbor

Tests for alkalinity were conducted once each at the State Line and Calumet River Mouth stations. These values were 106 and 108 mg/l, respectively.

Table 41. Alkalinity levels recorded at intakes of municipal water filtrations plants in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	104 - 115	107	11
Waukegan	104 - 112	107	12
North Chicago	104 - 110	107	10
Lake Forest	104 - 114	109	8
Highland Park	104 - 116	109	12
Glencoe	104 - 116	108	12
Winnetka	104 - 110	107	11
Kenilworth	104 - 112	108	12
Wilmette	102 - 111	106	12
Evanston	104 - 115	108	12
Chicago Central	104 - 111	107	12
Chicago South	104 - 112	107	12

HARDNESS

The principal effect of hardness is economic. Hard water forms scales in boilers, heaters, radiators and pipes, and is responsible for increased consumption of soap and detergents. Aside from economic considerations, hard waters have been shown to reduce the detrimental effects of toxic metals on aquatic life.

Offshore Stations

At the offshore stations hardness levels ranged from 130 to 140 mg/l at all three sampling depths. The average at each depth was 130 mg/l.

Water Plants

At the water plants hardness levels ranged from 130 to 150 mg/l in 1973. Individual plant averages ranged from 130 to 135 mg/l. For all plants the average was 130 mg/l (Table 42).

Calumet Harbor

Tests for hardness were conducted once each at the State Line and Calumet River Mouth stations. These values were 130 and 140 mg/l, respectively.

Table 42. Hardness levels recorded at intakes of municipal water filtration plants in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE	AVERAGE	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	130 - 140	135	11
Waukegan	130 - 140	130	12
North Chicago	130 - 140	130	10
Lake Forest	130 - 145	135	8
Highland Park	130 - 145	135	12
Glencoe	130 - 140	130	12
Winnetka	130 - 150	135	11
Kenilworth	130 - 140	130	12
Wilmette	130 - 140	130	12
Evanston	130 - 140	130	12
Chicago Central	130 - 140	130	12
Chicago South	130 - 140	130	12

HEAVY METALS

Samples were monitored for thirteen heavy metals during 1973. The analyses were performed on unfiltered samples and reflect the total (dissolved and suspended) concentrations of each metal.

Shore Water

Six samples were collected from each of the thirty-one shore water stations. The concentrations detected were low enough that, except for iron (0.14 mg/l) and manganese (0.03 mg/l), all the averages were below detectable levels. In reviewing the shore water data it should be remembered that the quantity of suspended sediment included in the sample varies with the surf conditions (Table 43).

Table 43. Heavy metal concentrations in Lake Michigan shore water during 1973. Concentrations are expressed in mg/l.

METAL	*STANDARD	SAMPLES ANALYZED	RANGE mg/l	AVERAGE mg/l
Arsenic	1.0	180	0.000 - 0.028	0.000
Barium	5.0	180	0.0 - 0.1	0.0
Boron	1.0	180	0.0 - 0.1	0.0
Cadmium	0.05	180	0.00 - 0.00	0.00
Chromium (Total)	1.0	180	0.00 - 0.00	0.00
Copper	0.02	180	0.00 - 0.02	0.00
Iron (Total)	1.0	180	0.00 - 3.2	0.14
Lead	0.1	180	0.00 - 0.09	0.00
Manganese	1.0	180	0.00 - 0.16	0.03
Mercury	0.0005	180	0.0000 - 0.0003	0.0000
Nickel	1.0	180	0.0 - 0.1	0.0
Selenium	1.0	179	0.00 - 0.00	0.00
Zinc	1.0	180	0.0 - 0.1	0.0

* General standards

Offshore Stations

Measurable concentrations of barium, cadmium, chromium (total), copper, manganese, nickel and selenium were not recorded in 1973. Arsenic was found in two samples; both had concentrations of 0.004 mg/l. A measurable concentration of 0.1 mg/l boron was recorded in one sample. Iron (total) concentrations of 0.1 mg/l were found in two samples. Lead was present in three samples. All of these values were 0.01 mg/l. Mercury concentrations ranging from 0.0002 to 0.0003 mg/l were found in six samples. Zinc was recorded in six samples. These values ranged from 0.1 to 0.3 mg/l (Table 44).

Table 44. Heavy metal concentrations recorded 5-miles offshore in Lake Michigan in 1973. Concentrations are expressed in mg/l.

METAL	STANDARD	RANGE	AVERAGE	SAMPLES ANALYZED
Arsenic	0.01	0.000 - 0.002	0.000	44
Barium	1.0	0.0 - 0.0	0.0	44
Boron	1.0	0.0 - 0.1	0.0	41
Cadmium	0.01	0.00 - 0.00	0.00	44
*Chromium (Total)	1.0	0.00 - 0.00	0.00	44
Copper	0.02	0.00 - 0.00	0.00	44
Iron (Total)	0.3	0.0 - 0.1	0.0	44
Lead	0.05	0.00 - 0.01	0.00	44
Manganese	0.05	0.00 - 0.00	0.00	44
Mercury	0.0005	0.0000 - 0.0003	0.0000	44
Nickel	1.0	0.0 - 0.0	0.0	44
Selenium	0.01	0.00 - 0.00	0.00	44
Zinc	1.0	0.0 - 0.3	0.0	44

The standards for Public and Food Processing Water are applicable except for Boron, Copper, Mercury, Nickel and Zinc, which are covered by the General Standard.

* No Standard

Water Plants

Analyses for barium, boron, cadmium, chromium (total), nickel and selenium did not yield detectable concentrations. Arsenic in measurable concentrations was recorded in nine samples. These values ranged from 0.002 to 0.005 mg/l. Copper concentrations ranging from 0.01 to 0.03 mg/l were found in 12 samples. Two had copper concentrations exceeding the standard. Measurable concentrations of iron (total) were found in 111 of 135 samples. These values ranged from 0.1 to 3.0 mg/l. Overall, 31% of the samples contained excessive iron (total) levels. Lead was present in three samples. One, with a concentration of 0.20 mg/l, exceeded the standard. Manganese in concentrations ranging from 0.01 to 0.58 mg/l was found in 42 samples. Of these, 10 samples contained excessive concentrations. Only one mercury sample yielded measurable concentrations. Zinc, in concentrations ranging from 0.1 to 0.6 mg/l, was found in 31 samples (Table 45).

Calumet Harbor

Arsenic, barium, cadmium, chromium (total), copper, nickel and selenium were not present in measurable concentrations. Boron was recorded in two of six samples. These concentrations, 0.1 mg/l, were within the standard. Cyanide was present in one of six samples. A Calumet River Mouth station sample contained 0.06 mg/l of cyanide, which exceeded both the general and public water supply standards. Iron (total) was present in four of six samples. These concentrations, 0.1 to 0.2 mg/l, were within the standards. A lead concentration of 0.01 mg/l was present in one of six samples. Manganese was found in four of six samples. One, from the State Line station, exceeded the public water supply standard although it was within the general standard. Values ranged from 0.02 to 0.06 mg/l. Mercury was recorded in one of six samples. This value, 0.0002 mg/l from the Calumet River Mouth station, was within the standard. Zinc was present in one of six samples. With a value of 0.1 mg/l, this concentration was within the standard.

Table 45. Heavy metal concentrations recorded at intakes of municipal water filtration plants in 1973. Concentrations are expressed in mg/l.

HEAVY METAL	STANDARD	SAMPLES ANALYZED	RANGE mg/l	AVERAGE mg/l
Arsenic	0.01	134	0.000 - 0.005	0.000
Barium	1.0	134	0.0 - 0.0	0.0
Boron	1.0	134	0.0 - 0.0	0.0
Cadmium	0.01	134	0.00 - 0.00	0.00
Chromium (Total)	1.0	134	0.00 - 0.00	0.00
Copper	0.02	121	0.00 - 0.03	0.00
Iron (Total)	0.3	135	0.0 - 3.0	0.3
Lead	0.05	134	0.00 - 0.20	0.00
Manganese	0.05	134	0.00 - 0.58	0.02
Mercury	0.0005	134	0.0000 - 0.0002	0.0000
Nickel	1.0	134	0.0 - 0.0	0.0
Selenium	0.01	134	0.00 - 0.00	0.00
Zinc	1.0	134	0.0 - 0.6	0.0

COLOR

Color in water can be caused by various natural substances or may be the result of certain chemicals in man-made wastes. The test for color indicates the color of a sample in comparison to a solution of a known concentration of platinum-cobalt in water. No current standard exists, but formerly, individual samples of Lake Michigan water could not exceed 15 units, and the annual average could not exceed 5 units.

Shore Water

In the shore water, the color determinations ranged from 2 to 32 units. Of the 388 samples analyzed, four had color readings in excess of 15 units. The annual average for all the samples was 2 units.

Offshore Station

At the offshore stations all 24 surface samples had a color value of 2 units. Mid-depth and bottom stations ranged from 2 to 4 units and 2 to 3 units, respectively. The average of 65 lake samples was 2 units.

Water Plants

At the water plants the maximum color readings ranged from 2 to 4 units in 1973. The average at all plants was 2 units.

Calumet Harbor

All seven samples from the Calumet Harbor stations had a color value of 2 units.

CHEMICAL OXYGEN DEMAND (COD)

Organic matter found in water undergoes various degrees of oxidation in the presence of strong, boiling acids. The chemical oxygen demand (COD) test measures, as oxygen equivalent, the oxidizable portion of such organic matter.

Offshore Stations

At the offshore stations the maximum COD levels ranged from 4 to 15 mg/l at the surface and from 4 to 12 mg/l at the mid-depth and bottom locations. The average of 60 samples from all depths was 6 mg/l.

Water Plants

The maximum COD levels at the water plants ranged from 11 to 29 mg/l in 1973. The plant-wide average of 125 samples was 8 mg/l (Table 46).

Calumet Harbor

Three samples from Calumet Harbor were analyzed for COD in 1973. Values of 7 and 12 mg/l were recorded at the State Line station and a single sample from the Calumet River Mouth station had a COD of 12 mg/l.

Table 46. COD levels recorded at intakes of municipal water filtration plants and within Calumet Harbor in 1973. Concentrations are expressed in mg/l.

SAMPLING LOCATION	RANGE mg/l	AVERAGE mg/l	SAMPLES ANALYZED
WATER PLANTS			
Zion-Benton	4 - 13	8	10
Waukegan	3 - 13	8	11
North Chicago	4 - 17	8	10
Lake Forest	4 - 15	8	7
Highland Park	4 - 12	8	11
Glencoe	4 - 13	8	11
Winnetka	5 - 12	8	10
Kenilworth	4 - 13	8	11
Wilmette	4 - 29	10	11
Evanston	4 - 11	8	11
Chicago Central	4 - 12	7	11
Chicago South	5 - 13	7	11

LAKE BED SURVEY

The State of Illinois has annually conducted a lake bed survey beginning in 1968. The authority to conduct this survey was provided in Senate Bill 1794 of the 75th General Assembly. This legislation required the annual collection and evaluation of information to determine the status of the quality and ecology of Lake Michigan.

Regulations incorporated into the 1972 Water Pollution regulations of Illinois state that all waters of the state shall have: "Freedom from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, unnatural color or turbidity, or matter in concentration or combinations toxic or harmful to human, animal, plant, or aquatic life of other than natural origin."

To evaluate the Lake bed environment one hundred and twenty-seven benthos samples were collected in 1973 using the Peterson and Ponar dredges. Each sample was washed through a 30 mesh screen. The remaining portion was preserved for later identification of the collected organisms. Each sample was classified as containing a balanced population of aquatic organisms or a degraded population. The system of classification is based on the presence or absence of intolerant aquatic organisms as indicated below:

ENVIRONMENTAL CLASSIFICATION

(Based on the Presence or Absence of Intolerant Aquatic Organisms)

- | | |
|---|---------------|
| 1. Many in number, many in species, or more in numbers than other forms present and approximately equal in number of species, or more in number of species. | BALANCED |
| 2. Less in number than other forms combined, but combined with moderate forms they outnumber tolerant forms, or similar in numbers to moderate forms but fewer in species. Tolerant forms less than or equal to intolerant forms. | UNBALANCED |
| 3. Few, if any, present. Other forms more numerous, or no intolerant forms present. Moderate and facultative forms present. | SEMI-POLLUTED |
| 4. Only tolerant forms present and usually many in numbers, or only tolerant forms present and few in numbers or no organisms present. | POLLUTED |
| 5. Natural or artificial bare area. | BARE AREA |

Generally a polluted condition is indicated by a population of 100 or more aquatic worms per square foot of bottom and a non-polluted situation is indicated by 150 scuds per square foot of bottom. Areas of high organic enrichment are indicated by aquatic worm populations in excess of 200 per square

foot. These criteria are considered together with the numbers and species of all organisms found in a sample to give the final classification. A well balanced population will include a variety of species.

A degraded environment usually reduces the total number of species while it increases the number of individuals of the few remaining species which are more tolerant of polluted conditions. Some areas completely devoid of aquatic life are classified as bare areas.

In 1973 eleven surveys were conducted along the near shore areas in Lake Michigan. Areas sampled and an evaluation of the aquatic environment are discussed in the following section.

Mouth of Kellogg Creek (Figure 3)

A total of ten benthos samples were collected in Lake Michigan offshore from the mouth of Kellogg Creek in Zion. Samples were collected at depths ranging from 10 to 25 feet. Scuds most frequently dominated samples from this area. A fine sand bottom predominated at most stations. Six stations were classified as balanced, three as natural bare areas, and one as unbalanced.

Mouth of Bull Creek (Figure 4)

A total of nine benthos samples were collected in Lake Michigan offshore from the mouth of Bull Creek in Zion. Samples were collected at depths ranging from 9 to 18 feet. Scuds most frequently dominated samples from this area. A fine sand bottom type predominated at most stations. Seven stations were classified as balanced and two as semi-polluted.

Mouth of the Dead River (Figure 5)

A total of seven benthos samples were collected in Lake Michigan offshore from the mouth of the Dead River in Zion. Samples were collected at depths ranging from 8 to 14 feet. Scuds dominated all samples from this area. A fine sand bottom type predominated at most stations. Six stations were classified as balanced and one as a natural bare area.

North Shore Sanitary District Waukegan Plant (Figure 6 and Table 47)

A total of 29 benthos samples were collected in Lake Michigan offshore from the discharge of the North Shore Sanitary District Waukegan plant. Samples were collected at depths ranging from 4 to 14 feet. Aquatic worms were not found in numbers greater than 61 per square foot. A fine sand bottom type predominated at most stations. Twelve stations were classified as balanced, eight as semi-polluted, six as natural bare areas, and three as unbalanced. These samples indicate a degraded environment at 79% of the stations sampled.

Mouth of the Waukegan River (Figure 6 and Table 48)

A total of 15 benthos samples were collected in Lake Michigan offshore from the mouth of the Waukegan River in Waukegan. Samples were collected at depths ranging from 10 to 20 feet. Aquatic worms numbered 188 or more at ten of the stations. Stations 2, 8, and 9 had concentrations of 3300, 32,000, and 1400 aquatic worms per square foot, respectively. A sanitary sewer bypass discharges to the lake in this area during periods of heavy rainfall. Nine stations were classified as polluted, three as unbalanced, two as semi-polluted, and one as balanced. These samples indicate a degraded environment at 93% of the stations sampled.

Montrose Harbor (Figure 7)

A total of six benthos samples were collected in Montrose Harbor and vicinity. Samples were collected at depths ranging from 14 to 26 feet. Aquatic worms numbered 170 or more at five of the six stations. Station 2 had an aquatic worm population of 3000. The bottom type predominating at the in-harbor stations was organic muck compared to a fine sand predominating at stations outside the harbor. All six stations indicated a degraded environment. Four stations were classified as polluted and two as semi-polluted.

Lincoln Park Gun Club and Diversey Harbor (Figure 8)

A total of 13 benthos samples were collected offshore from the Lincoln Park Gun Club and in Diversey Harbor. Samples were collected at depths ranging from 12 to 23 feet. Fine sand was the predominant bottom type at stations 1 through 8. An organic muck bottom predominated at stations 9 through 13. Aquatic worms at the in-harbor stations ranged from 304 to 8600 per square foot. Four stations were classified as polluted, four as semi-polluted, three as unbalanced and two as balanced. These samples indicate a degraded environment at 85% of the stations sampled.

Chicago Harbor (Figure 9 and Table 49)

A total of 22 benthos samples were collected in the Chicago Harbor. Samples were collected at depths ranging from 15 to 33 feet. An organic muck predominated at most stations. Aquatic worms in excess of 100 per square foot were found at 19 of the 22 stations. All stations indicated a degraded environment. Eighteen stations were classified as polluted, one as semi-polluted and three as unbalanced.

Burnham Harbor (Figure 10)

A total of three benthos samples were collected in Burnham Harbor. Samples were collected at depths ranging from 15 to 24 feet. The predominant bottom type was an organic muck. Aquatic worms ranged between 513 and 1100 per square foot at the three stations. All stations indicate a degraded environment and were classified as polluted.

Jackson Park Harbor - 59th Street (Figure 11 and Table 50)

A total of five benthos samples were collected in the 59th Street Harbor. Samples were collected at depths ranging from 10 to 13 feet. The predominant bottom type consisted of sand and detritus. Stations 2 through 5 had numbers of aquatic worms ranging from 370 to 884 per square foot. All stations indicate a degraded environment. Four stations were classified as polluted and one as semi-polluted.

Jackson Park Inner and Outer Harbor (Figure 11 and Table 51)

A total of eight benthos samples were collected in the Jackson Park inner and outer harbor. Samples were collected at depths ranging from 10 to 12 feet. The predominant bottom type in the outer harbor (stations 1 through 5) was sand compared to organic muck in the inner harbor (stations 6 through 8). Six of the stations had numbers of aquatic worms ranging from 132 to 6500 per square foot. All stations indicate a degraded environment. Four stations were classified as polluted, three as semi-polluted, and one as unbalanced.

Figure 3. Location and polluttional classification of stations sampled offshore from the mouth of Kellogg Creek in Zion. Data are expressed as numbers of organisms per square foot.

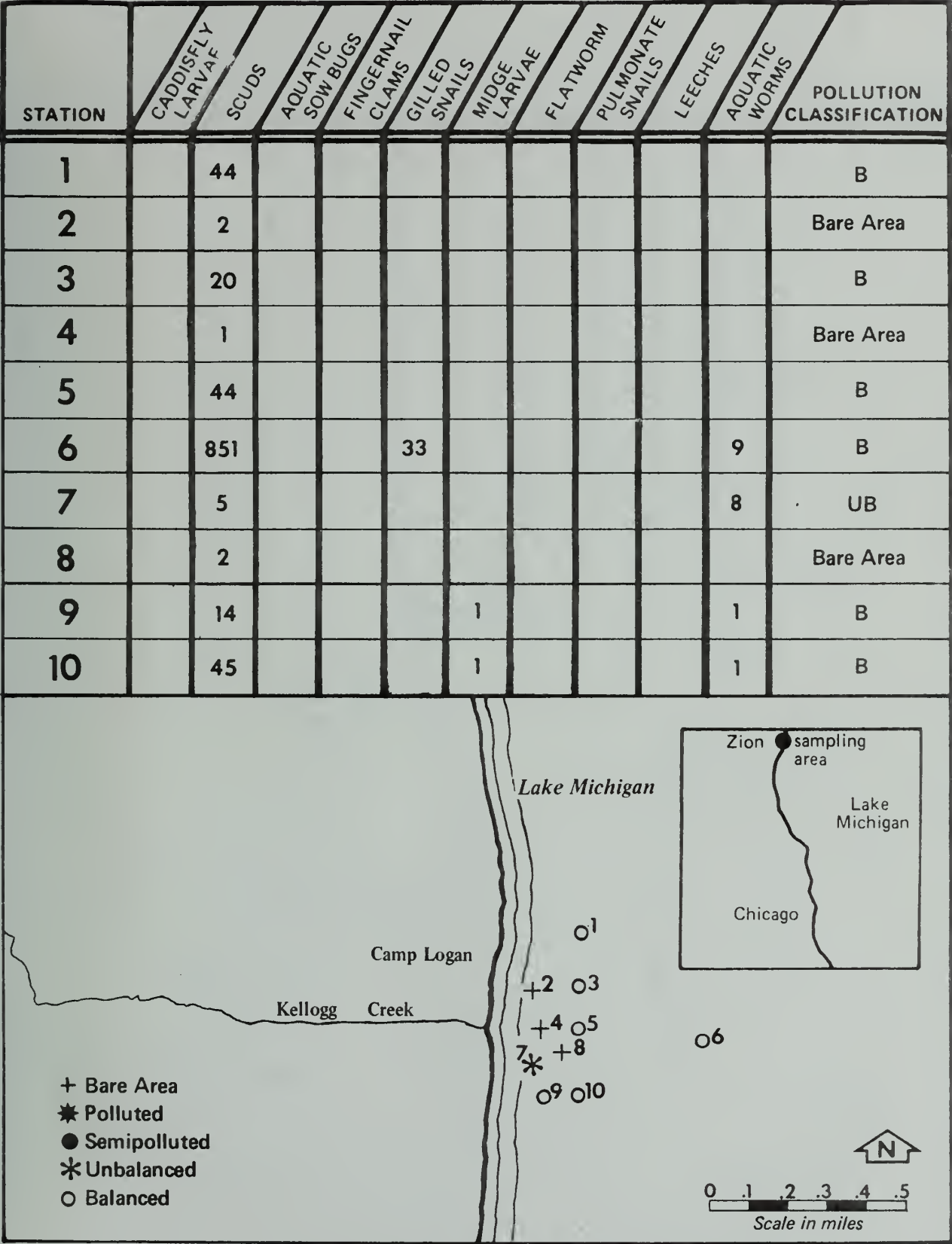


Figure 4. Pollutational classification of stations sampled offshore from the mouth of Bull Creek in Zion. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		2				2				2	SP
2		7									B
3		6								1	B
4		20		4		4			1	52	SP
5		31									B
6		12									B
7		20				2				1	B
8		12				1				4	B
9		22									B

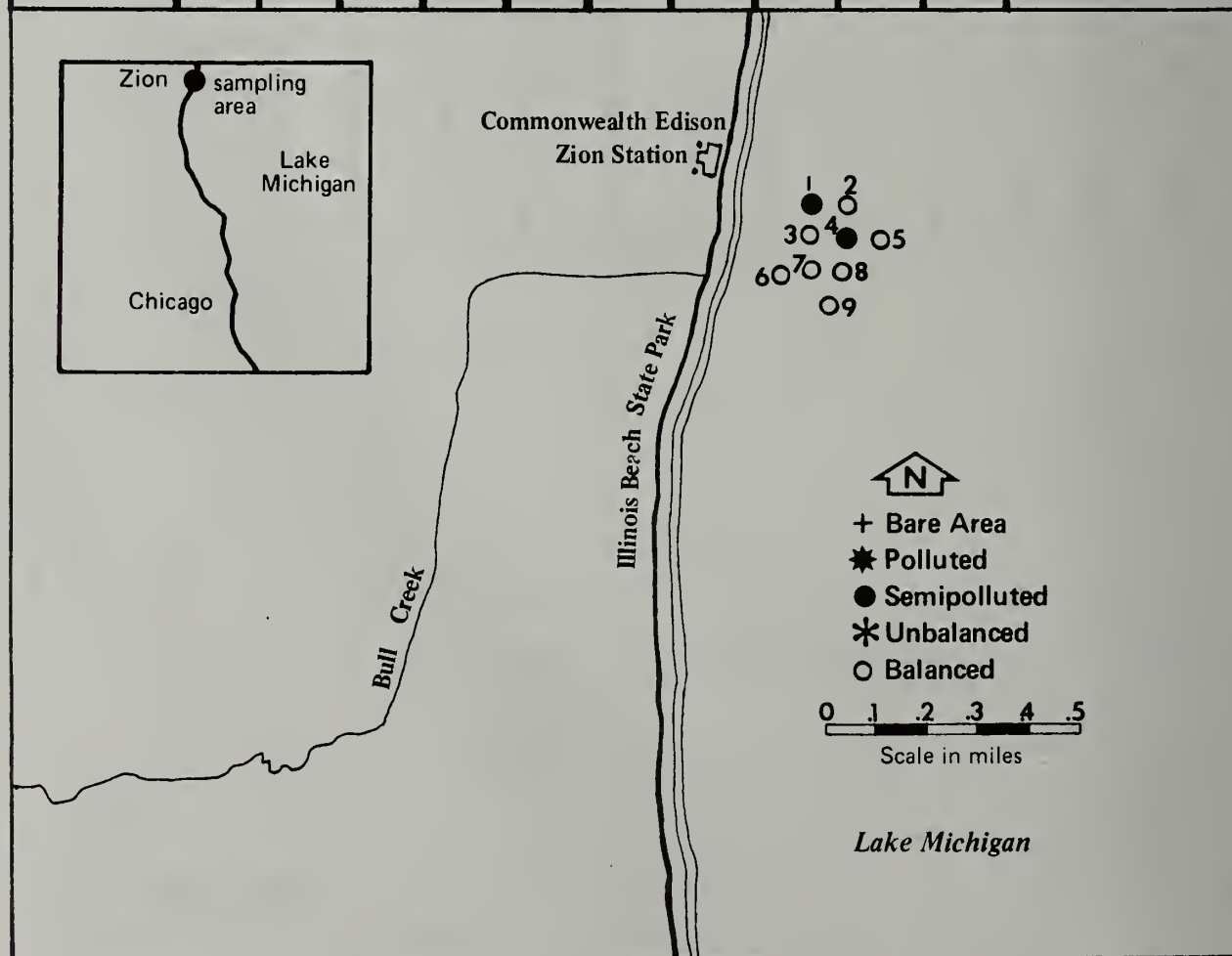


Figure 5. Location and pollutional classification of stations sampled offshore from the mouth of Dead River in Zion. Data are expressed as numbers of organisms per square foot.

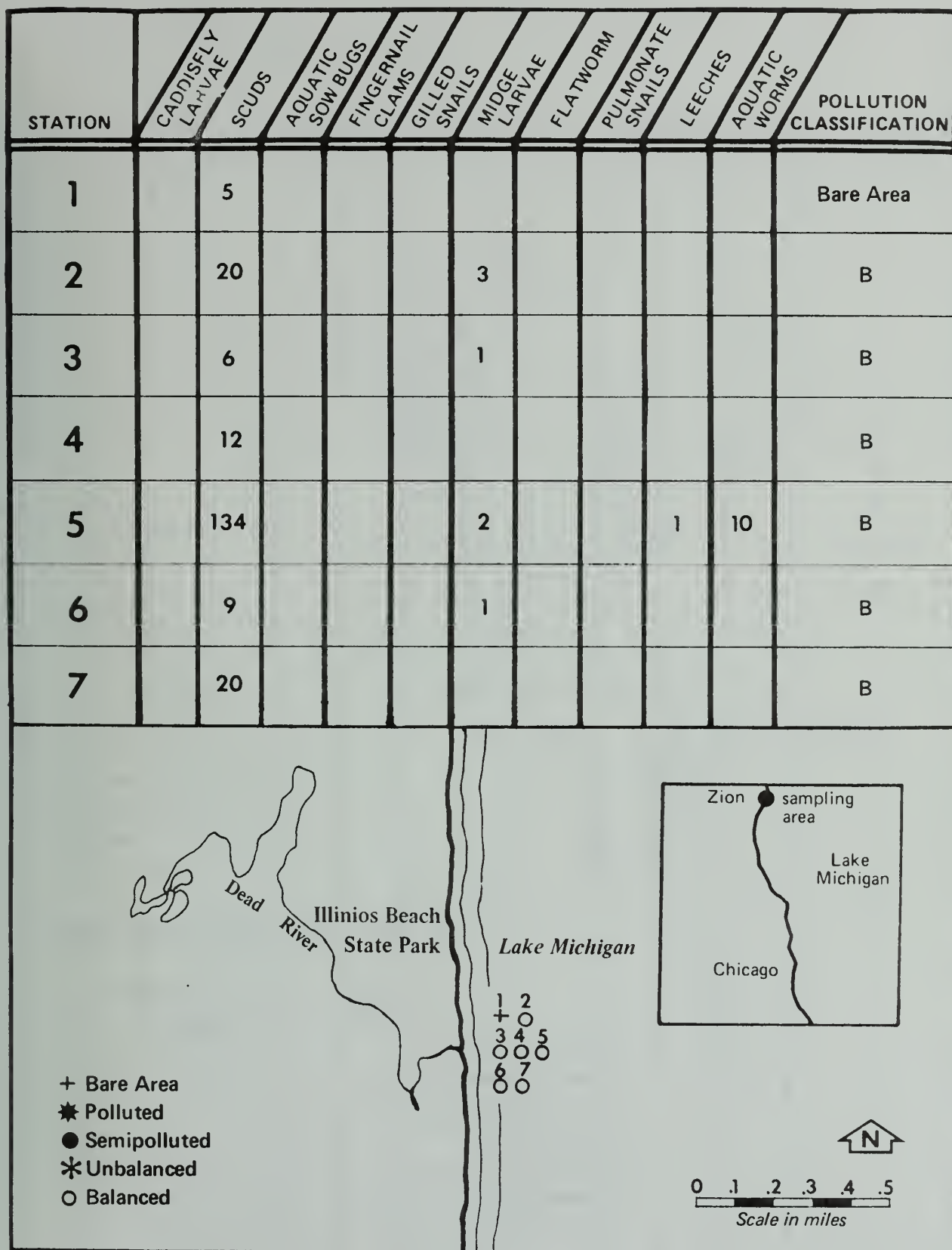


Figure 6. Location and pollutional classification of stations sampled offshore from the discharge of the North Shore Sanitary District sewage treatment plant and the mouth of the Waukegan River in Waukegan.

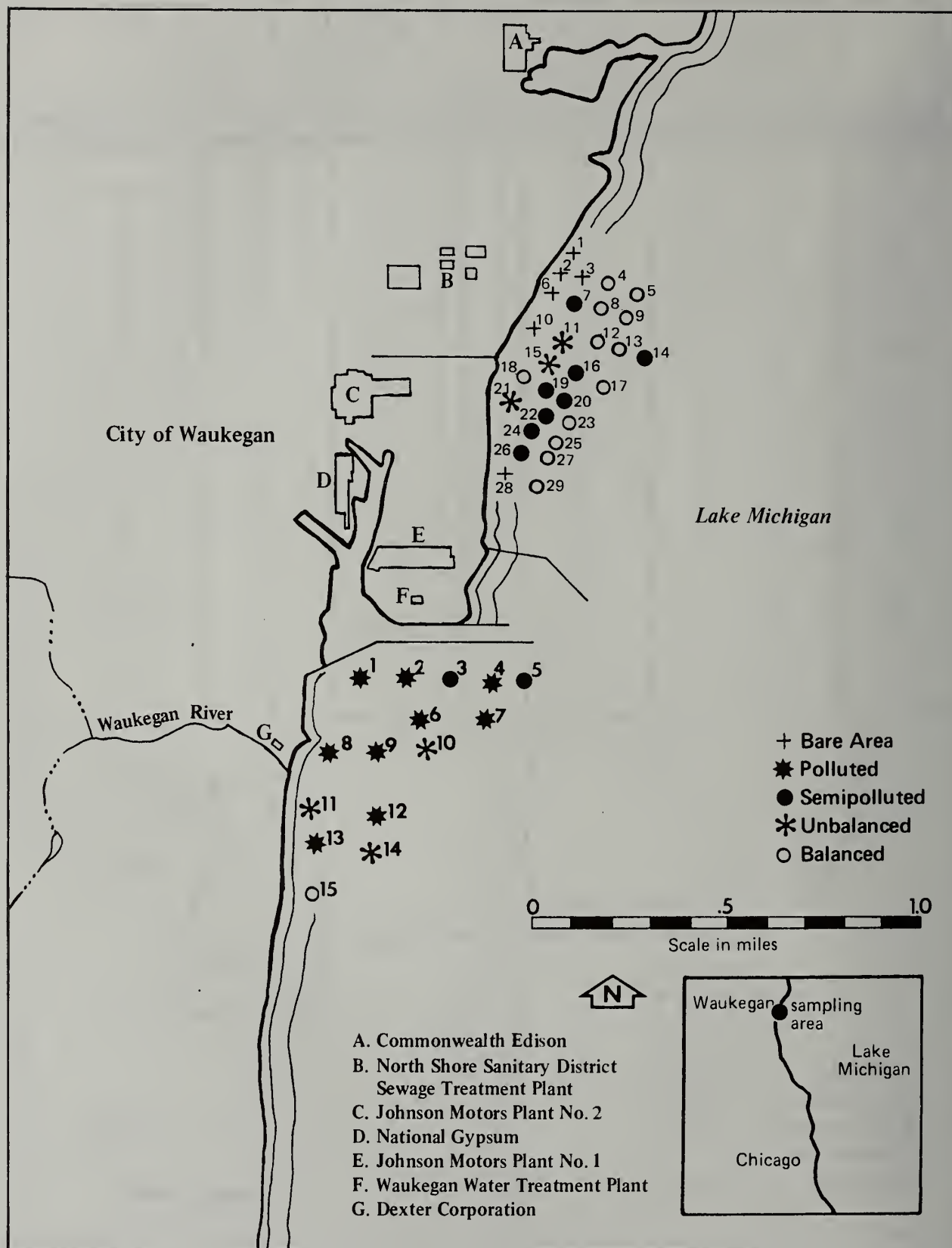


Table 47. Pollutational classification of stations offshore from the NSSD Waukegan sewage treatment plant. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		4				1					Bare Area
2		3									Bare Area
3				no	life	found					Bare Area
4		12				4				3	B
5		62		4	2	6				38	B
6										1	Bare Area
7		8		3				5		10	SP
8		21		4		4				6	B
9		10		1		3					B
10				no	life	found					Bare Area
11		10		1		5				4	UB
12		61		8		11				25	B
13		27		2		2				4	B
14		3								4	SP
15		4		1		4					UB
16		10		3		12				5	SP
17		35		1		12				11	B
18		12				1					B
19		12				9				20	SP
20		28				26				14	SP
21		2				1				1	UB
22		12				7				15	SP
23		34				8				9	B
24		20		2		12				59	SP
25		18		1		9				6	B
26		10				14				61	SP
27		29		3		12				9	B
28		1									Bare Area
29		25		1		10				9	B

Table 48. Polluttional classifications of stations sampled offshore from the mouth of the Waukegan River. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		1		14						226	P
2		11		33		46	1			3300	P
3		60		8		14				78	SP
4		52		12		10	1			188	P
5		199		4		2		1		251	SP
6		6		9		3				464	P
7		218		17		20				421	P
8				64		96			64	32000	P
9		11		1		5	2			1400	P
10		98		5		4				84	UB
11	1						12	2	8		UB
12		40		1		15		1		377	P
13		16								624	P
14		38		1		9				24	UB
15		47				3				13	B

Figure 7. Locations and polluttional classifications of stations in and near Montrose Harbor in Chicago. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARV, E	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1				527		28				812	P
2				240		68			16	3000	P
3	2	32	162		4	14	9	2	4	178	SP
4		7	2	32	7	107		2		602	P
5		11				5				23	SP
6		46		68	5	16	2			288	P

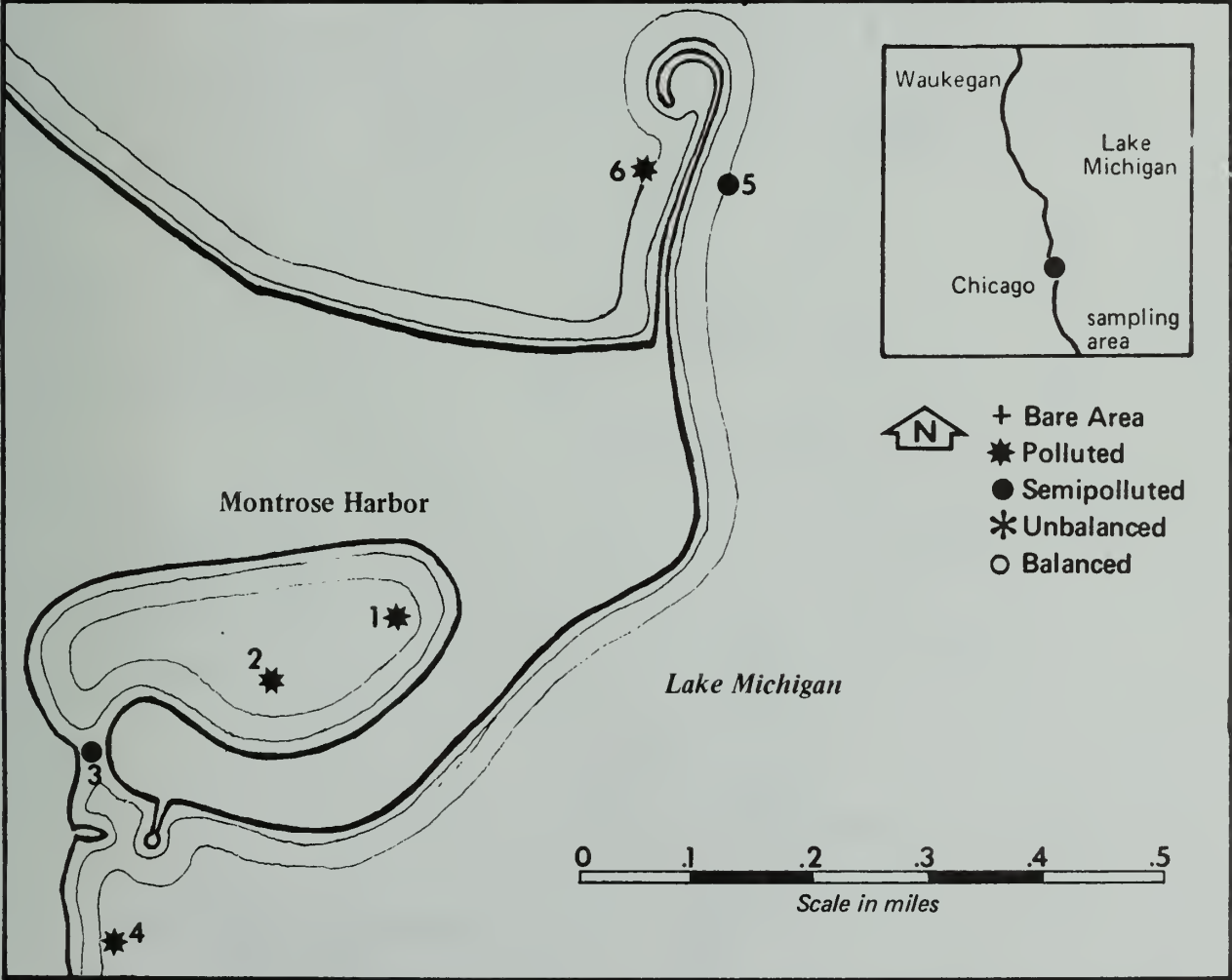


Figure 8. Location and pollutional classification of stations sampled in Diversey Harbor and offshore from Lincoln Park Gun Club in Chicago. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCULS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		23		21	2	11				77	SP
2		21		18		11				18	UB
3		7		4		16				84	SP
4		16		28	2	11				41	SP
5		20		53	9	7		2		52	UB
6		4		2						4	UB
7		125		4		4		4	2	5	B
8		21		2	5	7				5	B
9		92	68	176	36	12			8	664	P
10		4	4	164	68	148			20	8600	P
11		4		140	20	76			16	2400	P
12				92		104			20	2300	P
13		240	4	20	8	8		4		304	SP

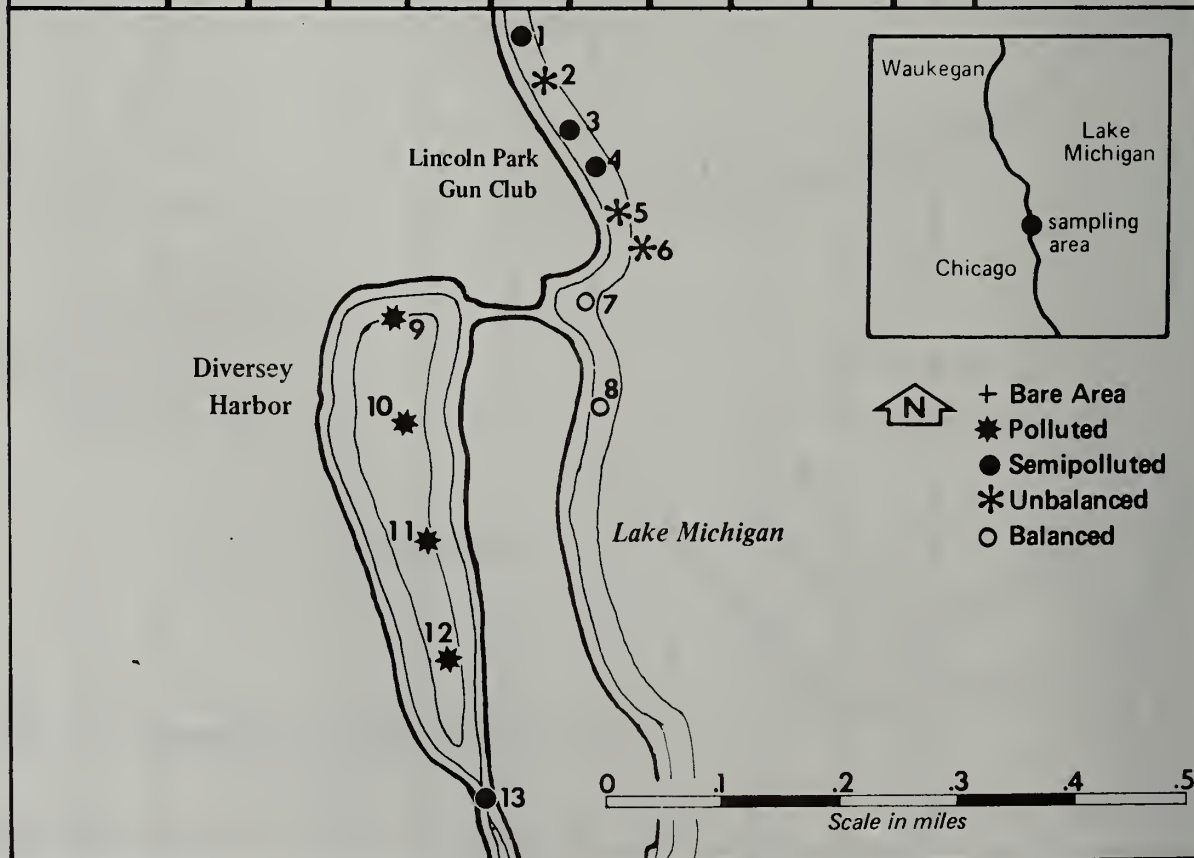


Figure 9. Location and pollutorial classifications of stations sampled in the Chicago Harbor area. Data are expressed as numbers of organisms per square foot.

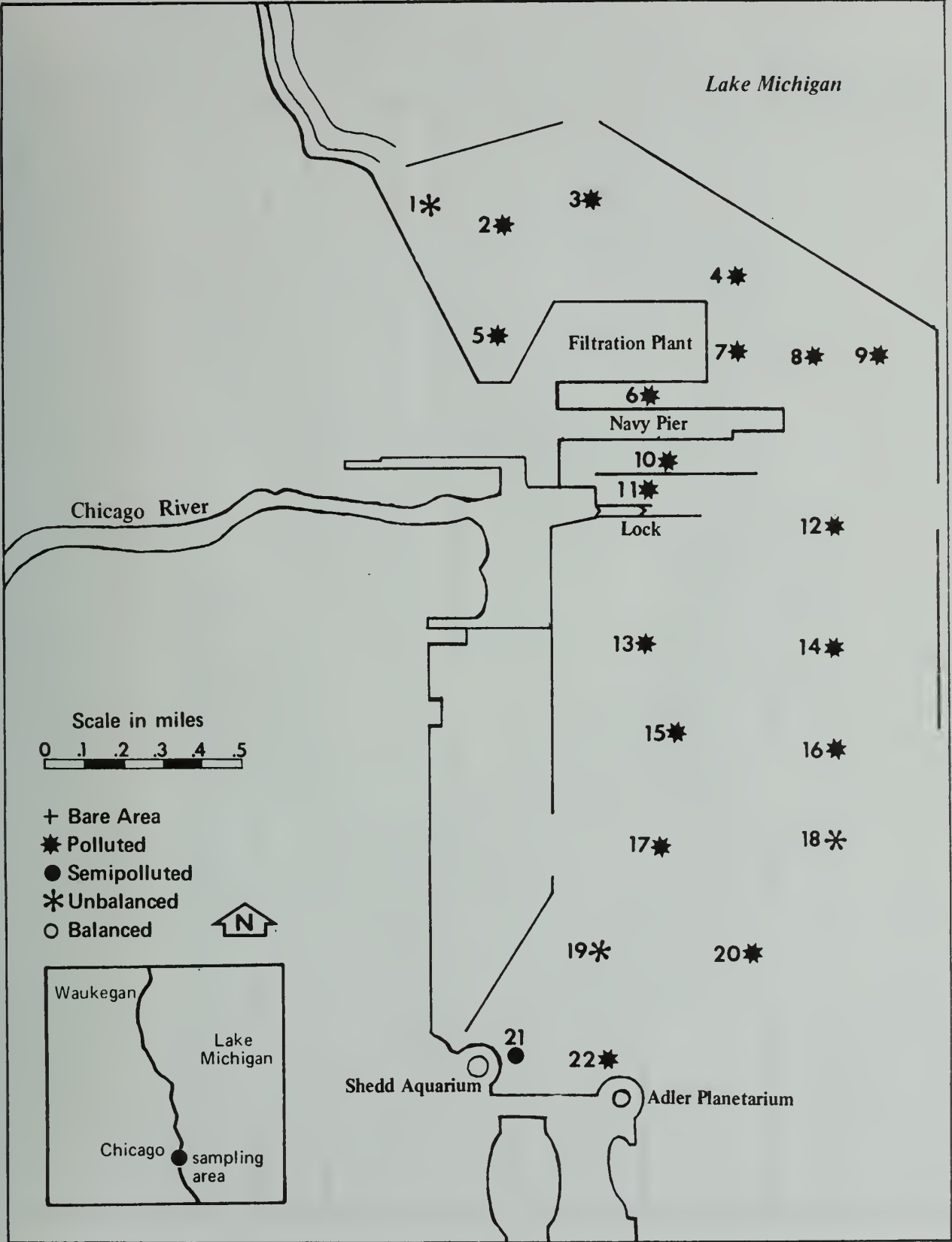


Table 49. Pollutional classification of stations sampled in the Chicago Harbor area. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		12		91	2	2			2	14	UB
2		20	78	388	32	7			107	1100	P
3		53	46	609	196	16		4	123	854	P
4	4	43	69	281		14		151	119	712	P
5	2	116	25	545	112	12			89	895	P
6				183	5	103			5	1300	P
7		21	46	308	100	20		7	96	1500	P
8	2	32	116	230	109			2	125	618	P
9		52	134	231	182	5		2	164	1200	P
10			32	59	4			2	11	383	P
11		59	87	203	68	96			30	319	P
12		4	358	176	62	4			358	8900	P
13		57	32	295	114	11	98	5	68	897	P
14		48	187	329	82	32		4	89	3100	P
15	2	103	470	316	749	16	16		97	733	P
16		61	340	379	105	7		5	80	1200	P
17		52	166	335	103			7	66	1400	P
18		50	231	498	116			2	75	158	UB
19	1	20		59	12	13	8	4	10	52	UB
20		4	62	427	110	23	5	9	9	509	P
21		7		12	4	2			4	44	SP
22		18		91	7	2		2	4	274	P

Figure 10. Location and pollutional classification of stations sampled in Burnham Park Harbor in Chicago. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1	14		14		14					726	P
2		7	132		23					1100	P
3			288	9	4			7		513	P

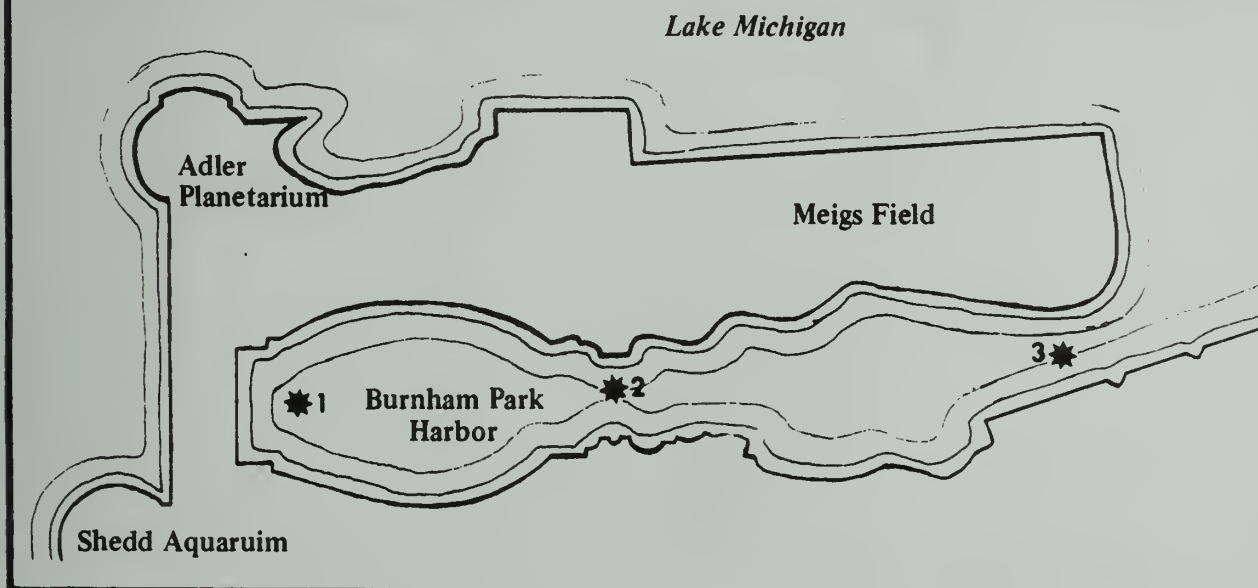
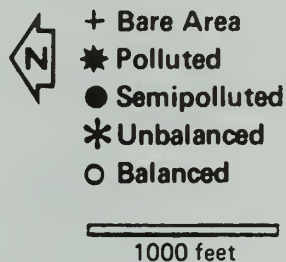
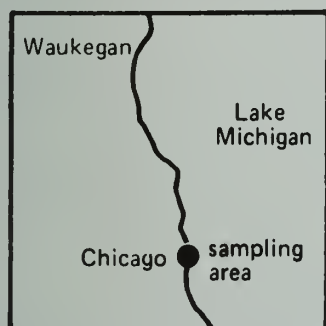


Figure 11. Location and pollutional classification of stations sampled in the Jackson Park Harbor areas in Chicago.

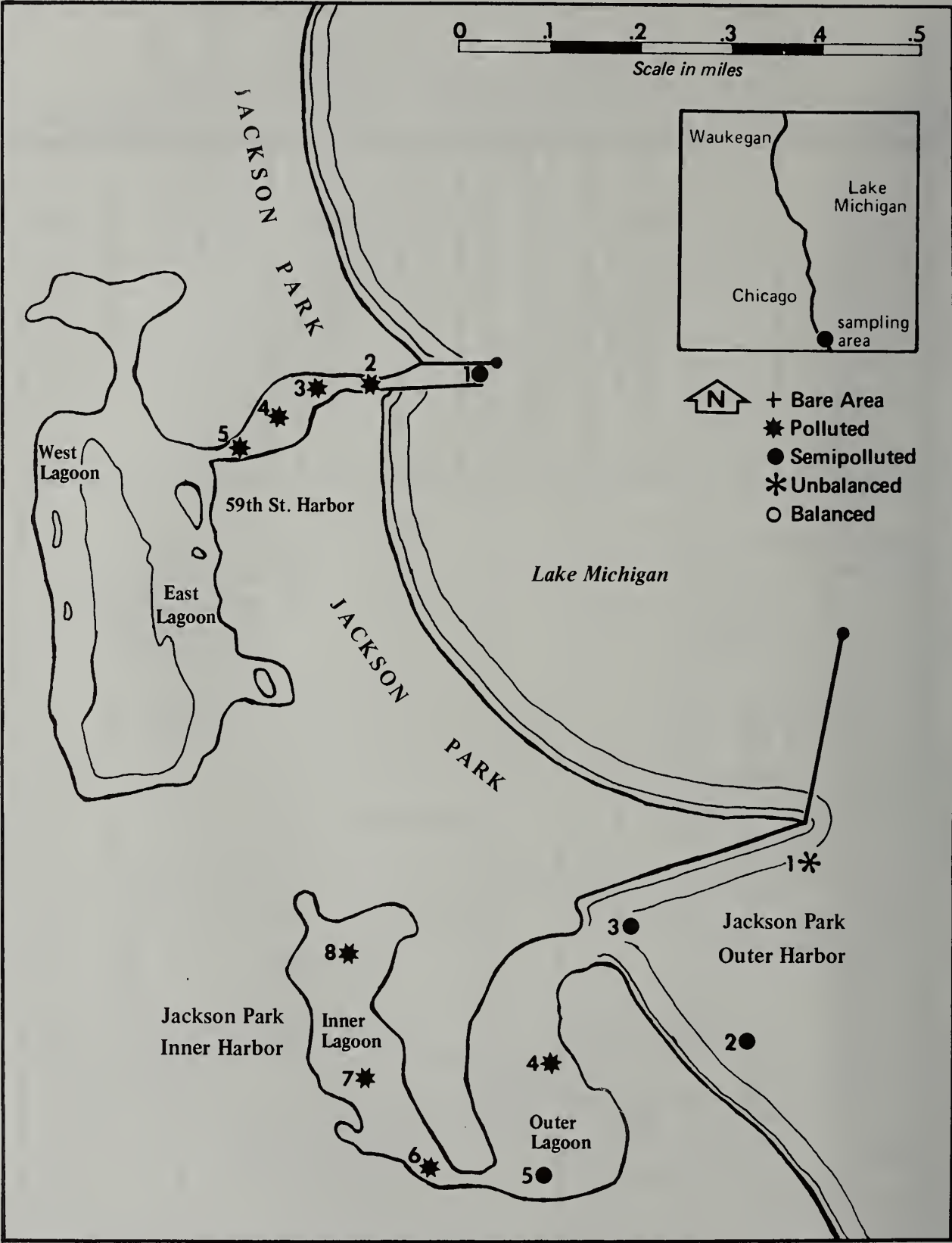


Table 50. Pollutational classification of stations sampled in the 59th Street Harbor in Jackson Park in Chicago. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		11		4	2	9				69	SP
2		401		21		171				370	P
3		8	4	4		120			8	684	P
4		12				120				784	P
5		68		16		252	4			884	P

Table 51. Pollutational classification of stations sampled at the outer and inner Harbors of Jackson Park in Chicago. Data are expressed as numbers of organisms per square foot.

STATION	CADDISFLY LARVAE	SCUDS	AQUATIC SOW BUGS	FINGERNAIL CLAMS	GILLED SNAILS	MIDGE LARVAE	FLATWORM	PULMONATE SNAILS	LEECHES	AQUATIC WORMS	POLLUTION CLASSIFICATION
1		21		157	14	28		11		132	UB
2		45		53	16			2		142	SP
3				100	37	301				59	SP
4				199		479				6500	P
5		16		2		18				91	SP
6				16		76				204	P
7				8		60				988	P
8		8		4		200			4	1600	P

GENERAL INFORMATION

Potentially harmful contaminants have been found in Lake Michigan water. These include the chlorinated hydrocarbon pesticides, polychlorinated biphenyls, phthalates and heavy metals. Heavy metals in Lake Michigan water are discussed in an earlier portion of this report. Monitoring programs by the Lake Michigan States are presently underway. Monitoring is being conducted as much as practicable to follow recommendations of the Lake Michigan Toxic Substances Committee. The Committee will issue a report in 1974 indicating the findings of the Committee, progress, needs and recommended control programs for Lake Michigan.

PESTICIDES

On June 25, 1969, the Pesticide Control Law was passed in Illinois. The act provided for labeling of pesticides to prevent contamination of water and environment by regulating, restricting or prohibiting the sale, use or application of pesticides. The sale, use or application of DDT was prohibited in Illinois without a permit from the Director of the Department of Public Health, effective January 1, 1970.

Effective January 1, 1972 licensing of custom or public application of pesticides was established under the control of the Department of Agriculture.

On March 24, 1972, at a public hearing, the Interagency Committee approved rules and regulations to the Pesticide Control Law promulgated by both the Department of Agriculture and the Department of Public Health. These rules and regulations prohibit the sale, use or application of sodium fluoroacetate (1080) and fluoroacetamide (1081) effective July 1, 1972, except by prior permit from the department having jurisdictional control.

Chlorinated hydrocarbon pesticides are undesirable in the environment because they may persist for months and years following application. In 1973, analyses were performed by the Illinois Environmental Protection Agency for DDT, heptachlor epoxide, and dieldrin in water and fish samples.

In October 1972, amendments to the Federal Insecticide, Fungicide and Rodenticide Act provided authority to the United States Environmental Protection Agency to regulate pesticides used for food and fiber production and disease control. The authority includes registration and labeling of pesticides used in interstate commerce. The USEPA can order the removal or stop the sale of an unregistered hazardous pesticide and assess fines against violators.

POLYCHLORINATED BIPHENYLS

Polychlorinated biphenyls have recently been found in Lake Michigan water, sediment and fish. PCB's, which are extremely persistent chlorinated hydrocarbons, have been found to accumulate through food chains of fish and birds, and may have an effect on reproductive potential of these as well as other forms of wildlife.

PCB's are used in the production of adhesives, asphalt, elastomers, electrical insulation, fire-resistant heat transfer and hydraulic fluids, special lubricants,

sealants and expansion media, synthetic rubber, floor tile, printers ink, coatings for paper and fabrics, pigments, resin, paints, varnishes and waxes.

In 1973 data was collected on Aroclor 1242 and Aroclor 1254 in 30 water and 69 fish samples.

PHTHALATES

Phthalates are chemical compounds of recent environmental concern. They are used as plasticizers in the plastics industry, particularly in the production of polyvinyl chloride plastics.

Two phthalate esters, DOP (di (2-ethylhexyl) phthalate) and DBP (di-n-butyl phthalate), have been encountered in the routine analysis of Lake Michigan water for DDT. Subsequent investigations by others have confirmed the presence of phthalates in fish, especially those taken from bodies of water associated with large urban and industrial areas.

In 1973 data was collected on sewage treatment plant effluents and streams tributary to Lake Michigan.

RESULTS OF MONITORING

PESTICIDES, POLYCHLORINATED BIPHENYLS AND PHTHALATES

WATER SAMPLES

A total of thirty water samples were collected at Kellogg Creek, the Waukegan River, Pettibone Creek, and the North Shore Sanitary District sewage treatment plants at North Chicago and Waukegan (Table 47).

DOP (di (2-ethylhexyl) phthalate) and Aroclor 1254 were found at higher concentrations at both the sewage treatment plant and stream stations. There was an apparent increase in concentrations of phthalates over the 1972 concentrations.

Maximum values for heptachlor epoxide and total DDT were found at the stream stations. Concentrations of heptachlor epoxide were similar to 1972 levels while there was a reduction in levels of total DDT. Maximum values for DOP and Aroclor 1254 were greater than those found in 1972. Maximum values for dieldrin and Aroclor 1242 were slightly lower. DBP, the o,p'isomers of DDT, and Aroclor 1242 were rarely detected in both stream and sewage treatment plant effluents.

A maximum value of heptachlor epoxide was 11.2 ppt obtained at the Kellogg Creek Station. Pettibone Creek recorded the maximum value of 81.0 ppt total DDT. The North Shore Sanitary District Waukegan sewage treatment plant recorded maximum values for dieldrin (22.0 ppt) and Aroclor 1254 (1100.0 ppt). The North Shore Sanitary District sewage treatment plant at North Chicago recorded the maximum value of DOP (5100.0 ppt). There was an extreme variability in the phthalate and polychlorinated biphenyl data which makes any determination of trends impossible. Improved analytical and sampling procedures may be needed in order to determine trends in these low concentrations.

Table 52. Pesticides, PCB's, and phthalates found in water samples from Illinois streams and sewage plants tributary to Lake Michigan in 1973. Values are expressed in parts per trillion (ppt).

LOCATION	DATE COLLECTED	HEPTACHLOR EPOXIDE	DIELDRIN	PHTHALATES		o, p' isomers			p, p' isomers			TOTAL		AROCLOR	
				DOP(1)	DBP(2)	DDE	DDD	DDT	DDE	DDD	DDT	DDT	DDT	1242	1254
Kellogg Creek	5-16-73	1.0	2.0	380.0	480.0	ND	ND	ND	8.0	12.0	16.0	36.0	ND	ND	200.0
Kellogg Creek	7-31-73	ND(3)	4.0	110.0	ND	ND	ND	ND	9.0	1.0	5.0	15.0	ND	ND	40.0
Kellogg Creek	8-15-73	11.2	8.0	230.0	ND	ND	ND	ND	2.7	ND	23.0	25.7	ND	ND	82.0
Kellogg Creek	9-19-73	ND	8.0	ND	ND	ND	ND	ND	4.0	10.0	9.0	23.0	ND	ND	38.0
Kellogg Creek	12-12-73	<1.0	1.0	140.0	ND	ND	ND	ND	2.0	ND	7.0	9.0	ND	ND	62.0
Waukegan River	5-16-73	2.0	6.0	870.0	68.0	ND	ND	ND	2.0	24.0	16.0	42.0	ND	ND	280.0
Waukegan River	7-31-73	11.0	3.0	960.0	ND	ND	ND	6.0	3.0	7.0	16.0	32.0	ND	ND	18.0
Waukegan River	8-15-73	5.2	4.9	340.0	ND	ND	ND	ND	4.9	7.2	10.6	22.7	ND	ND	32.0
Waukegan River	9-19-73	ND	7.0	ND	ND	ND	ND	ND	8.0	17.0	11.0	36.0	ND	ND	67.0
Pettibone Creek	1-17-73	4.0	8.0	3200.0	ND	ND	ND	ND	4.0	13.0	25.0	42.0	ND	ND	180.0 (5)
Pettibone Creek	5-16-73	2.0	2.0	380.0	ND	ND	ND	ND	4.0	13.0	21.0	38.0	ND	ND	240.0
Pettibone Creek	7-31-73	ND	3.0	480.0	ND	ND	ND	ND	11.0	9.0	13.0	33.0	ND	ND	75.0
Pettibone Creek	8-15-73	5.4	6.6	320.0	ND	ND	ND	6.8	6.7	3.8	11.6	28.9	ND	ND	30.0
Pettibone Creek	9-19-73	ND	4.0	ND	ND	ND	ND	ND	3.0	9.0	69.0	81.0	ND	ND	51.0
Pettibone Creek	12-12-73	<1.0	3.0	100.0	ND	ND	ND	ND	1.0	3.0	6.0	10.0	ND	ND	67.0
NSSD Waukegan STP	2-7-73	3.0	10.0	1300.0	ND	ND	ND	2.0	6.0	6.0	20.0	34.0	(4)	(4)	260.0
NSSD Waukegan STP	4-9-73	5.0	22.0	2300.0	80.0	ND	ND	22.0	10.0	14.0	34.0	80.0	(4)	(4)	270.0
NSSD Waukegan STP	6-5-73	4.0	8.0	3800.0	110.0	ND	ND	ND	4.0	4.0	10.0	18.0	ND	ND	100.0
NSSD Waukegan STP	8-29-73	ND	4.0	1700.0	ND	ND	ND	ND	4.0	5.0	10.0	19.0	100.0	100.0	94.0
NSSD Waukegan STP	9-12-73	ND	3.0	650.0	ND	ND	ND	4.0	2.0	4.0	9.0	19.0	ND	ND	60.0
NSSD Waukegan STP	10-9-73	ND	11.0	1400.0	ND	ND	ND	ND	4.0	5.0	11.0	20.0	250.0	250.0	64.0
NSSD Waukegan STP	11-7-73	<1.0	4.0	1400.0	ND	ND	ND	ND	1.0	3.0	16.0	20.0	ND	ND	50.0
NSSD Waukegan STP	12-4-73	2.0	5.0	4400.0	ND	ND	ND	ND	3.0	5.0	13.0	21.0	ND	ND	1100.0
NSSD North Chicago STP	2-7-73	10.0	20.0	2000.0	170.0	ND	ND	ND	8.0	24.0	22.0	54.0	ND	ND	340.0
NSSD North Chicago STP	6-5-73	4.0	6.0	5100.0	160.0	ND	ND	ND	2.0	4.0	4.0	10.0	ND	ND	80.0
NSSD North Chicago STP	8-29-73	ND	3.0	2400.0	ND	ND	ND	ND	6.0	2.0	27.0	35.0	220.0	220.0	240.0
NSSD North Chicago STP	9-12-73	2.0	3.0	850.0	ND	ND	ND	ND	10.0	4.0	11.0	25.0	ND	ND	100.0
NSSD North Chicago STP	10-9-73	ND	4.0	3300.0	ND	ND	ND	ND	1.0	4.0	9.0	14.0	ND	ND	33.0
NSSD North Chicago STP	11-7-73	<1.0	1.0	2400.0	ND	ND	ND	1.0	2.0	1.0	10.0	14.0	ND	ND	20.0
NSSD North Chicago STP	12-4-73	3.0	4.0	720.0	ND	ND	ND	ND	4.0	10.0	15.0	29.0	650.0	650.0	75.0

(1) DOP = di (2-ethyl hexyl) phthalate

(2) DBP = di-n-butyl phthalate

(3) ND = Not Detected

(4) Present but not quantified due to interference

(5) Identification as Aroclor 1254 not certain

FISH SAMPLES

Analysis of fish samples by this Agency are directed toward the determination of environmental contamination by various contaminants. The data included in this report and the reference to various recommended standards should not be used for questions relating to public health. Fish samples analyzed were obtained from an edible fillet for all species except the alewife which were analyzed whole including head, tail, and viscera. For fish smaller than one pound such as the yellow perch most of the edible portion was used. For fish larger than one pound including most of the salmon and trout a dorsal fillet was obtained from immediately behind the gill cover and above the lateral line. The sample fillet collected in most cases was approximately one pound for the larger fish.

The Technical Committee on Pesticides established by the Lake Michigan Enforcement Conference recommended that the concentrations of pesticides in fish should not exceed 1.0 parts per million DDT, 0.5 parts per million DDD, 0.1 parts per million dieldrin, and that all other chlorinated hydrocarbon pesticides, singly or combined, should not exceed 0.1 parts per million based on the wet weight of the tissue sampled. The U.S. Food and Drug Administration has established a 5.0 ppm action level on both DDT and polychlorinated biphenyls.

A total of 69 fish were collected in 1973 and analyzed for total DDT, polychlorinated biphenyls, dieldrin, phthalates, and heptachlor epoxide (Table 48.). The fish species analyzed included yellow perch, chinook salmon, brown trout, lake trout, rainbow trout, coho salmon, carp, white sucker, northern pike, and alewife.

Polychlorinated biphenyl concentrations varied considerably between species. It is apparent that the larger trout and salmon contain the highest levels of Aroclor 1254. Seven chinook salmon in excess of 24 inches in length averaged 11.4 ppm of Aroclor 1254. Seven brown trout in excess of 15.5 inches averaged 7.0 ppm of Aroclor 1254. Concentrations of Aroclor 1254 in yellow perch and alewife were 1.2 and 2.1 ppm, respectively. Only limited numbers of lake trout, rainbow trout, coho salmon, carp, white sucker and northern pike were sampled which prevented obtaining reliable average concentrations for these species.

Total DDT concentrations were generally below 5.0 ppm except for the larger chinook salmon. Seven chinook salmon in excess of 24.0 inches had an average concentration of total DDT of 5.5 ppm. Two chinook salmon of 10.0 and 11.0 inches averaged 0.5 ppm total DDT. The increased concentrations of these contaminants probably occur during rapid growth periods with the increasing amount of fatty tissues which concentrate both DDT and polychlorinated biphenyls. The magnification in concentration of these contaminants is evident in the higher predators of the food chain. The salmon and trout are known to feed heavily on the alewife in Lake Michigan. Fish with concentrations of polychlorinated biphenyls or DDT greater than 5.0 ppm are considered unacceptable by the U.S. Food and Drug Administration for sale in interstate commerce.

Concentrations of phthalates were not consistently found in fish samples. At the present time it does not appear that phthalates constitute a substantial contamination problem. Further advancements in analytical technique will be required in order to adequately evaluate the impact of phthalates on the Lake Michigan ecosystem.

Table 53. Pesticide and PCB concentrations found in the edible portions of Lake Michigan fish in 1973. Values are expressed in parts per million (ppm) on a wet weight basis.

SPECIES	NUMBER AND SEX ANALYZED	SIZE IN INCHES	SAMPLE LOCATION	DATE COLLECTED	DIELDRIN	TOTAL DDT	AROCLOR 1254	HEPTOCHLOR EPOXIDE
Yellow Perch	2 Female	8.5 - 9.0	Waukegan	10-11-73	< 0.1	0.1	0.1	< 0.1
Yellow Perch	5 Female	7.0 - 10.0	Winnetka	10-11-73	< 0.1	0.4	1.1	< 0.1
Yellow Perch	1 -----	6.5	Winnetka	10-11-73	< 0.1	0.4	0.9	< 0.1
Yellow Perch	2 Male	8.5 - 9.0	Winnetka	10-11-73	< 0.1	0.7	2.6	< 0.1
Yellow Perch	5 Male	8.0 - 10.5	Waukegan	10-11-73	< 0.1	0.1	0.4	< 0.1
Yellow Perch	5 Male	7.5 - 9.0	Winnetka	10-11-73	< 0.1	0.2	1.3	< 0.1
Yellow Perch	5 Male	7.5 - 8.5	Winnetka	10-11-73	0.1	0.7	1.8	-----
Chinook Salmon	1 -----	11.0	Chicago	11-6-73	0.1	0.6	1.1	< 0.1
Chinook Salmon	1 -----	10.0	Winnetka	10-11-73	< 0.1	0.3	0.4	< 0.1
Chinook Salmon	1 Male	36.0	Chicago	11-6-73	0.1	6.0	15.3	0.1
Chinook Salmon	1 Male	38.5	Chicago	11-6-73	0.1	6.2	15.0	< 0.1
Chinook Salmon	1 Male	24.0	Chicago	11-6-73	0.1	3.3	10.6	-----
Chinook Salmon	1 Male	27.0	Chicago	11-6-73	< 0.1	4.2	10.1	< 0.1
Chinook Salmon	1 Male	34.0	Chicago	11-6-73	0.1	6.9	9.5	< 0.1
Chinook Salmon	1 Female	36.5	Chicago	11-6-73	< 0.1	6.6	12.2	< 0.1
Chinook Salmon	1 Female	34.5	Chicago	11-6-73	0.1	5.2	6.9	< 0.1
Brown Trout	1 -----	20.0	Chicago	11-21-73	0.1	1.6	9.6	< 0.1
Brown Trout	1 Female	19.0	Winnetka	10-11-73	< 0.1	1.3	2.3	< 0.1
Brown Trout	1 Female	25.5	Chicago	11-6-73	0.2	6.6	10.7	< 0.1
Brown Trout	1 Female	22.0	Chicago	11-6-73	0.1	3.3	5.6	< 0.1
Brown Trout	1 Female	9.5	Chicago	11-21-73	< 0.1	0.2	0.4	< 0.1
Brown Trout	1 Female	9.0	Chicago	11-21-73	-----	0.1	0.3	< 0.1
Brown Trout	1 Female	9.0	Chicago	11-21-73	< 0.1	0.1	0.4	< 0.1
Brown Trout	1 Female	22.5	Chicago	11-21-73	0.2	4.9	9.9	< 0.1
Brown Trout	1 Male	24.0	Chicago	11-21-73	0.1	1.7	7.2	-----
Brown Trout	1 Male	15.5	Chicago	11-6-73	< 0.1	1.3	3.9	< 0.1
Lake Trout	1 Male	21.5	Waukegan	10-11-73	0.2	2.5	7.0	< 0.1
Lake Trout	1 Female	25.0	Winnetka	10-11-73	0.3	11.0	15.2	< 0.1
Rainbow Trout	1 Female	19.0	Waukegan	10-11-73	0.1	0.5	0.9	< 0.1
Rainbow Trout	1 Male	24.5	Chicago	11-21-73	< 0.1	1.0	2.5	< 0.1
Coho Salmon	1 Female	24.0	Chicago	11-21-73	< 0.1	0.5	1.6	< 0.1
Coho Salmon	1 Female	23.0	Chicago	11-21-73	0.1	3.2	8.6	< 0.1
Carp	1 Female	34.0	Chicago	11-21-73	0.1	4.5	7.0	-----
Carp	1 Male	19.0	Chicago	11-21-73	< 0.1	0.3	13.6*	-----
White Sucker	1 -----	12.5	Chicago	11-21-73	< 0.1	0.1	0.2	< 0.1
Northern Pike	1 -----	15.0	Chicago	11-6-73	< 0.1	0.3	0.9	< 0.1
Alewife	5 Female	7.0 - 8.0	Waukegan	6-14-73	0.1	1.3	1.6	< 0.1
Alewife	3 Female	7.0 - 9.0	Waukegan	6-14-73	0.1	1.5	3.7	< 0.1
Alewife	2 Male	7.0 - 7.5	Waukegan	6-14-73	0.1	1.1	2.5	< 0.1
Alewife	5 Male	6.0 - 7.5	Waukegan	6-14-73	0.1	0.9	1.6	< 0.1

*Aroclor 1248

INDUSTRIAL WASTE

ABBOTT LABORATORIES (Manufacturers of drugs, antibiotics and pharmaceuticals). Abbott operates a waste treatment plant which provides secondary treatment of extremely strong industrial waste. Until the North Shore Sanitary District's new facilities are completed at Gurnee, Abbott will continue to mix effluent with their cooling water discharge. This reduces the impact of the waste at the point of discharge and causes the effluent to be, generally, in compliance with the standards. When the N.S.S.D. project is completed, Abbott will no longer discharge wastes to Lake Michigan.

COMMONWEALTH EDISON COMPANY, WAUKEGAN STATION (Fossil fuel electric generating station). This plant has been operating since 1927. At full capacity, the maximum temperature rise through the condensers is 120F. Extensive studies of the thermal plume on the localized portion of the lake have identified no adverse effects.

COMMONWEALTH EDISON COMPANY, ZION STATION (Nuclear fuel electric generating station). Though portions of this facility were completed in 1972, the Atomic Energy Commission did not issue a permit for operation. At full capacity, the maximum temperature rise through the condensers is not expected to exceed 200F. The Illinois Pollution Control Board has authorized the facility to utilize Lake Michigan for cooling, providing all the requirements listed in the thermal regulations are met.

FANSTEEL INCORPORATED (Producers of corrosion-resistant metals used for electrical and chemical applications). During 1973, Fansteel completed special pretreatment facilities which made possible the elimination of one of their two discharges of toxic wastes. The remaining discharge enters Pettibone Creek roughly one mile upstream from its confluence with Lake Michigan. The effluent occasionally exceeds the standards, but it will be eliminated in early 1974.

JOHNSON MOTORS, DIVISION OF OUTBOARD MARINE CORPORATION (Manufacturers of outboard motors). The effluent from oil separating equipment is discharged to Waukegan harbor and through a ditch to Lake Michigan several hundred yards north of Waukegan's North Beach. Metals concentrations are generally within the state guidelines. Occasional oil discharges seldom pass the barriers and baffles which cross the effluent ditch.

UNITED STATES STEEL CORPORATION, WAUKEGAN WORKS (Producers of stainless and carbon steel wire and springs). In-plant improvements and acid waste hauling for deep well disposal in Gary, Indiana, have resulted in major reduction of acid and metals discharged from this facility. The present discharge via several outfalls, occasionally exceeds the state's effluent guidelines.

UNITED STATES STEEL CORPORATION, SOUTH WORKS (Steel smelting plant). This plant presently has outfalls discharging to Lake Michigan and the Calumet River. A court order issued January 18, 1971 requires a closed cycle system by 1975.

ILLINOIS DISCHARGES

SEWAGE

NORTH SHORE SANITARY DISTRICT Seven municipal sewage treatment plants discharge to the Illinois portion of Lake Michigan. They are operated by the North Shore Sanitary District and are located in Waukegan, North Chicago, Lake Bluff, Lake Forest and three in Highland Park. The Waukegan and North Chicago plants provide secondary biological treatment while the others are primary sedimentation sewage treatment plants. All use chlorine to disinfect their effluents.

The North Shore Sanitary District is now engaged in an extensive construction program, which, when completed, will divert all sewage effluents from the Lake Michigan watershed. The program provides for the diversion of the effluents from the Lake Bluff, Lake Forest and Highland Park plants to the District's Clavey Road sewage treatment plant. The North Chicago sewage treatment plant effluent will be diverted to a new facility to be located in Gurnee (DesPlaines River watershed). Supplementary treatment and phosphate reduction facilities will be provided at the Waukegan sewage treatment plant. The effluent from the Waukegan plant will then be pumped for discharge to the DesPlaines River.

Litigation initiated by a group of Highland Park residents substantially delayed the project. However, as interim measures, the district installed chlorination equipment to disinfect the bypass flows, and chemical feed equipment to provide better treatment and reduce the phosphorus content of the discharges.

Although total diversion will not be completed for several years, partial diversions are being made as the project proceeds. The dry weather flows from all five of the primary sewage treatment plants will be pumped to the Clavey Road facility by early 1974. The expansion of the Waukegan sewage plant is also expected to be completed in early 1974. Combined sewer overflows should be eliminated before the beginning of the 1974 swimming season.

MILITARY INSTALLATIONS The Great Lakes Naval Training Center and the Army's Fort Sheridan operate sewage treatment plants providing secondary treatment.

The Navy has completed negotiations to divert their flows to the North Shore Sanitary District. The diversion must await the completion of the new facility at Gurnee. During the interim, the Navy has employed the addition of ferric chloride to improve their effluent quality and comply with the phosphorus regulations.

The sewage treatment plant at Fort Sheridan is currently operating at less than the design capacity, due to the transferring of Fifth Army Headquarters. The base is expected to connect to the NSSD when the Clavey Road STP expansion is completed. No interim measures for phosphorus reduction have, as yet, been implemented.

ILLINOIS DISCHARGES

WATER PLANT WASTE

The water Pollution regulations, adopted by the Pollution Control Board, in 1972, extended the deadline for the elimination of backwash water discharges from water filtration plants. The new deadline for compliance is Dec. 31, 1974.

Additionally water plants were required to discontinue the practice of flushing settling basin sludge into the lake by July 1972. The municipalities which have not, as yet, installed the necessary improvements are Waukegan, Highwood, Highland Park and Glencoe.

M.S.D.G.C. OVERFLOWS

All of the lake shore municipalities in Cook County (Glencoe through Chicago) are served by the Metropolitan Sanitary District of Greater Chicago. Except for several surface drains, no sewers within the jurisdiction of the District discharge directly to Lake Michigan. The District's three major sewage treatment plants and combined sewers (sewage and storm water) discharge to a system of waterways which are tributary to the DesPlaines River. The waterways receive flow from Lake Michigan regulated by facilities at Wilmette, downtown Chicago and the O'Brien lock on the Calumet River.

Lock and dam facilities prevent back-flow of contaminated river water into Lake Michigan. Heavy rains may cause such heavy discharge to these waterways that the water level rises above the level of the lake resulting in back-flow through the locks and overflow of the dams. Therefore, the District maintains an alert system with the Lockport control facilities. Whenever heavy rain is predicted, the Lockport Dam lowers the water level in the rivers and thereby prevents or minimizes the discharge from the MSDGC waterways to Lake Michigan.

The following list indicates the dates on which reverse flows occurred over the past five years:

1973	None
1972	June 14, August 26, September 17
1971	None
1970	None
1969	October 10

AMMONIA (NITROGEN) - A chemical parameter used to evaluate water quality. Ammonia nitrogen is found naturally in surface and ground waters as a result of the decomposition of nitrogenous organic matter. Industrial wastes and sewage effluents contribute to background concentrations.

BENTHOS - Bottom dwelling organisms. In this report only organisms retained in a U.S. Standard No. 30 sieve were used.

CHLORIDE - A chemical parameter used to evaluate water quality. Chlorides are one of the most common components of natural bodies of water. They may be of natural origin, or may be present as a result of agricultural runoff, sewage contamination or industrial discharges.

CYANIDE - A chemical parameter used to evaluate water quality. The presence of toxic cyanide in the aquatic ecosystem is primarily the result of industrial waste discharges. Industrial processes involving the scrubbing of gases at steel mills, metal cleaning and electroplating processes, and the effluents from gas works, coke ovens and from chemical industries are the major inputs of cyanide to the lake environment.

DETRITUS - A mixture of organic and inorganic material formed from the decomposition of dead plant and animal forms and from settleable mineral materials.

EUTROPHICATION - The natural aging process of a body of water.

FACULTATIVE AQUATIC ORGANISMS - Organisms that tolerate a wide range of environmental conditions.

FECAL COLIFORM - A group of bacteria, which inhabits the intestinal tracts of warm-blooded animals, and has been shown to be a reliable indicator of recent contamination by feces of warm-blood animals.

FLUORIDE - A chemical parameter used to evaluate water quality. Fluorides occur in certain types of rocks, and are not commonly found in significant concentrations in surface waters. They are used in the manufacture of glass, enamels and steel, for the preservation of wood and mucilages, in insecticides, in chemical industries and in public water supplies where fluoridation is practiced.

FOOD CHAIN - A progression of food organisms in the aquatic environment which range from a large number of microscopic forms to a smaller number of large forms which are dependent on the smaller forms for their ultimate survival. A typical food chain would range from phytoplankton to the zooplankton (animal plankton) to the fishes.

INTOLERANT AQUATIC ORGANISMS - Aquatic organisms which require an environment free from pollution in order to survive.

IRON (total) - A chemical parameter used to evaluate water quality. Iron may occur in natural waters through the leaching action of soluble iron salts from soil and rocks. Major sources of iron to aquatic environments are iron and steel mills, the organic and inorganic chemical industries, petrochemical and fertilizer plants and glass ceramic processing industries.

METHYLENE BLUE ACTIVE SUBSTANCE - A component of synthetic detergents, MBAS is introduced into the aquatic environment primarily via the effluents of sewage treatment plants.

NITRATE PLUS NITRITE - A chemical parameter used to evaluate water quality. Nitrates are the metabolic end products of organic nitrogen decomposition. They are commonly found in surface waters as a result of the decomposition of organic nitrogen in polluted streams, and from sewage effluents, agricultural runoff, cesspool leaching and industrial discharges. Nitrites in natural waters result from bacterial action upon ammonia and organic nitrogen. Because they are readily oxidized to nitrates, nitrites are not normally found in significant concentrations in surface waters.

If present in sufficient concentrations in public water supplies, nitrates and nitrites may cause infant methemoglobinemia, a disease causing blood changes and cyanosis.

pH - pH is the logarithm of the reciprocal of the hydrogen ion concentration. In practice, it is the measurement of the hydrogen ion concentration. By definition the pH range is from 0, which is very acidic, to 14, which is very alkaline. Since the concentration of hydrogen ions regulates the degree of dissociation of many substances, pH may be a significant factor in determining limiting threshold concentrations in natural waters. Abnormal fluctuations in pH may be an indication of industrial waste discharges.

PHENOL - A chemical parameter used to evaluate water quality. Phenols are associated with industrial wastes from coal distillation processes, and the manufacture of plastics, dyes and disinfectants. In public water supplies inadequate chlorination of phenol contaminated water produces odor and taste problems. Phenols in water may be toxic to fish and also impart tastes to fish flesh.

PHOSPHORUS - A chemical parameter used to evaluate water quality. It is significant when present in excessive amounts. Eutrophication may be accelerated by high phosphorus levels. Phosphorus enters the aquatic environment via agricultural and surface runoff, industrial waste discharges and sewage effluents.

PHTHALATES - A group of chemical compounds used as plasticizers in the plastics industry.

PHYTOPLANKTON - Phytoplankton are the minute, mostly microscopic plant organisms which drift in the water subject to the action of waves and currents. They are a primary source of food for aquatic organisms and some fish.

POLYCHLORINATED BIPHENYLS - A group of chlorinated hydrocarbons used in the production of a wide variety of materials including adhesives, lubricants inks, varnishes and hydraulic fluids. Aroclor 1242 and Aroclor 1254 are two of the PCB's which have been found in Lake Michigan.

SULFATE - A chemical parameter used to evaluate water quality. Sulfates are a component of natural bodies of water. Abnormal fluctuations in background levels are usually the result of industrial waste discharges.

TOLERANT AQUATIC ORGANISMS - Aquatic organisms capable of surviving in a polluted environment.



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